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M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

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ON another page will be found the first of a second series of articles on "Practical Railroad Information." Like the first series, this will be based on the results of many years' experience in the Testing Department of a large railroad; but while the first dealt with results, this series will describe the methods used in testing. It will contain much that has never before been made public, and much valuable information.

THE plans for the new rapid transit line in New York are nearly finished, and the Commission will soon be ready to take the next step and offer the franchise for sale. It will then be seen whether any capitalists are willing to undertake the building of the line. Some doubt has been thrown over this by the cutting off of the most valuable part of the franchise—that for a line through the densely populated east side of the city and into the annexed district north of the Harlem River, which is growing more rapidly than any other part of the city.

IN this connection it may be noted that the New York Central & Hudson River Company has unaccountably neglected its opportunities of serving the annexed district. It has a line already built to the center of the city, and were proper facilities given, its Harlem Division might carry three times the business it now does. Under the present system the business which really belongs to it is being carried off by the Suburban Elevated and other lines, while the growth of the district is checked by the lack of transportation. A short-sighted policy like this is not to the credit of the company.

THE annual statement of the Sault Ste. Marie Canal for the year ending June 30 shows an enormous business. The number of vessels passing through the canal was 11,557, or 2,027 more than in the previous year, and a greater number than ever before. To pass these vessels required 5,615 lockages. They carried over 25,000 passengers and 10,107,622 tons of freight. The figures show that the average distance each ton of freight was carried was 820 miles, and the average rate was extremely low, being only 0.135 cent per ton-mile.

It may be noted that the total number of passages given above was made by 652 vessels—that is, each passed through the canal an average of 17½ times. Of these vessels 595 belonged to the United States and 57 to Canada. The largest cargo taken through was by the steamer *E. C. Pope*, and consisted of 103,000 bushels of wheat.

The great lock at Sault Ste. Marie now enjoys the distinction of passing a greater tonnage than any other canal lock in the world, the business far exceeding that of the Suez Canal.

THE bids for the new Croton Dam, the plans for which were recently described, were all rejected by the New York Department of Public Works; and new bids are to be advertised for.

THE great drawback to the Southern iron trade heretofore has been that the pig iron produced in the Alabama and other districts has had too large a proportion of silicon and phosphorus to be used in making Bessemer steel. It is now stated that a process recently invented by Benjamin Talbot, of Chattanooga, has been successful in removing the silicon, and it is claimed that by the use of this method steel of a good quality can be produced at a very moderate cost. The process is to have a thorough practical test on a large scale. If it succeeds, it will be a matter of very great importance to the Southern ironmakers—and to their Pennsylvania competitors as well.

IT is stated that considerable changes have been made in the armor plans for some of the new ships. The turrets for the *New York* are to have straight vertical instead of inclined sides, and in some of the other ships the form of the armor will be a series of straight lines, instead of corresponding to the lines of the ship.

It is said that these changes are made to hasten construction by avoiding the difficulties incurred in bending heavy plates to the exact shapes. It is unfortunate that this has appeared to be necessary, and it is to be hoped that as little of this kind of work as possible will be done.

THE effort to concentrate the road exhibit at Chicago has not been abandoned, and is to be continued by Colonel Pope and others as long as there is any possibility of success. It will certainly be a mistake if the effect of the exhibit of machinery and appliances of such an important class is weakened by scattering it about through several different buildings. It should be kept together so that those interested in the subject could study it carefully, and the attention of many others, who ought to be interested, may be easily drawn to it. It is somewhat late now to make a new classification, but it ought to be done if there is any possible way to do it.

THE most valuable through train which ever crossed the continent was one which arrived in New York on the morning of August 9, carrying $20,000,000 in gold sent from the sub-treasury in San Francisco to that in New York. It consisted of four baggage cars carrying the gold and a sleeping car for the guards who accompanied it. It was in charge of officials of the Post-Office Department, and was well guarded throughout its journey; but

no attempt was made to interfere with the safe transit of the treasure.

The train made an exceptionally fast run, leaving San Francisco at 6.30 P.M. on August 4, and reaching New York at 10.46 A.M. on August 9; the total time was thus 4 days, 13 hours, 16 minutes, or less than an hour more than the time made by the fastest continuous through train on record.

TWO companies at least—the Pennsylvania Company and the Illinois Central—are making provision for the short travel to the Chicago Exposition next year by building what may be called temporary passenger cars—that is, they are cars built up on freight-car platforms and sills, with light sides and a freight-car roof and framing. They will be provided with comfortable seats and will answer for short excursion travel, and after the extra demand is over they can be converted into freight cars.

WHAT is the finest and most expensive passenger station was a question lately discussed by some men of experience, according to the Philadelphia *Record*. The handsomest architecturally was said to be that of the Great Indian Peninsular line at Bombay, which took ten years to build. The most commodious was the new union station at Frankfürt-am-Main, Germany, while the most costly were two of the terminal stations in London and the North British station in Edinburgh, which were made so by the enormous prices paid for the property they occupy.

THE Chief Engineer of the Navy has prepared recently a new system of examinations for promotion in the Engineer Corps of the Navy, which is said to be very comprehensive and thorough. Candidates for promotion will have to be thoroughly versed in the theory and practice of the modern marine engine and boiler, and in methods of propulsion of vessels, while some knowledge of electric-lighting plants and their management will also be necessary.

THE LABOR QUESTION.

DOUBTLESS many of those who read the above title will feel the same sense of weariness in doing so that we do in writing it. For weeks the daily papers have been full of accounts of strikes, attended with violence and bloodshed, and at times it seems as though a civil war was impending. It is impossible for a fair-minded man to say of either side that it is altogether right and the other altogether wrong. Of course, when murder and arson are roaming hand in hand over the country, all law-abiding people will agree that the first duty is to suppress such crime, and enforce the laws and re-establish security to life and property, and settle the disputes afterward, if that is possible. It has been said by some one that it is a mistake to assume that the function of law and government is to administer justice; its first object is to stop contention and preserve order, and this takes precedence over the administration of justice. Therefore, the first duty of law-abiding people in the community is to suppress violence at any cost of injustice to labor—men or employers—or, if need be, any sacrifice of life. Even in the midst of war, though, we may speak and think of the means of attaining peace.

With reference to the causes of the switchmen's strike at Buffalo, the daily papers report that "Grand Master Workman" Sweeney made the following statement:

> Certainly the men have done everything that a man with an ounce of self-respect could do to avoid forcing the issues to a strike. The Lehigh Valley men first asked for a reform in certain places on June 11 last. The companies' officers refused to listen to anything. They have the idea that they can drive the men and frighten them into submission, but they are mistaken. Switchmen cannot be driven. There is no question of the justice of their demands. The public, the newspapers, even the companies, admit that a man should be paid for all the hours he works, and should receive a decent, respectful hearing if he finds that he is being abused. These men ask that they be paid by the hour, and that they be given time to eat their dinner. Not unreasonable demands, are they?
>
> They also ask that when their committees go to the officers of the road to call the attention of the officers to abuses in a respectful manner the committees be accorded common civility. The committee that waited on Superintendent Burrows of the New York Central were insulted by him, and were at once discharged. They reported to the organization, and as a result of Burrows' brutal, overbearing conduct the men are out. Nobody to blame but Burrows.

Now, we have not the slightest means of knowing how far or how near this statement is to or from the exact facts, or what mitigating circumstances there may be which, if known, would modify these charges. Some allowance ought doubtless to be made for the heat of the weather and of Mr. Sweeney's brain.

In another daily paper the same official is reported as saying that Mr. McLeod, the President of the Reading system, "declined to even see the committee of the organization which went to interview him," and that

> The committee that called on the New York Central officials were discharged in a body by Mr. Rossiter, the Assistant Superintendent of the Western Division, merely for making their grievances known. They were subsequently reinstated, however.
>
> They were subsequently discharged peremptorily by Yardmaster Maloney. A second committee went to the company with the same grievance, and expecting to meet with the same fate. Mr. Rossiter told them the other committee had been discharged because they lied to him.

The difficulty of getting at facts in the present excited state of the minds of the parties on both sides of this dispute is apparent when at the end of the same article it is reported that Mr. Voorhees, the General Superintendent of the New York Central Railroad, denied all knowledge of the statement made by Mr. Sweeney that the members of the Committee of Grievances had been discharged for coming before him. He said they had been suspended for leaving their work without permission, and that the suspension only lasted five days.

The exact measure of truth in these statements is not important, however, for our present purpose, which is to call attention to a lecture delivered by M. Julien Weiler, which is reprinted on another page, and which gives some experience and suggestions with reference to this question of the treatment and recognition of committees of the men. In other words, the question propounded is whether it is wise to refuse to receive and hear committees appointed by the unions of the men to represent their interests? There can be no doubt that it gives the men a decided advantage to be thus represented, and, to quote from Mr. Thornton's excellent treatise on labor, "On what pretence are they to be denied the privilege of having their cause argued for them by attorney." As a consequence, as pointed out by M. Julien Weiler, of the danger of dismissal, the best men are indisposed to serve on committees. The blatherskites, then, take their places, and the difficulty of rational negotiation is much increased. In some cases men to serve on committees are selected from

trades outside of the one which has a grievance to present, in order that the committee may not incur the danger of dismissal by such service. Surely it cannot be a wholesome relation between employers and men when the most clear-headed, the most industrious, intelligent, and conservative are prevented from representing their own interests and those of their associates to their employers. "To him that worketh," says St. Paul, "reward is reckoned, not of grace, but of debt." Some railroad officials seem to be slow in taking this apostolic view.

In the present condition of lawlessness the paramount question is, of course, its suppression ; but under a reign of law the complete recognition of the right of men to be represented by committees of their own number would, it is believed, do more than any other step to prevent misunderstandings and contentions between men and their employers.

COMPOUND LOCOMOTIVES.

ANY one who has served on juries often must have noticed that during the effort to come to an agreement, in cases concerning which there is any marked difference of opinion, the conduct of nearly all juries is very nearly alike. On having a case submitted for a verdict, a majority of the jurors are at first reticent and indisposed to reveal their opinions—if they have any—while one or two are apt to announce their conclusions decisively. There is then a little cautious argument, which gradually grows into warm discussion. A vote will likely be taken to see how the members stand. After the vote, if opinions differ, discussion will be renewed, mildly at first, but increasing in warmth, until one half will probably be shouting. Some are then reduced to silence, and finally the loud administrators of justice grow weary, and boisterous argument is succeeded with tranquility, and then rational discussion may again be possible and some jurors made amenable to sound reason.

The compound locomotive discussion seems to have gone through most of these different stages and to have reached the period of tranquility, so that we may now expect enlightened discussion, and a fair consideration of the evidence which has been submitted.

A seeker for information concerning the relative merits of compound and non-compound locomotives, after examining the subject is apt, too, to find himself in the same confused state of mind that jurors are often in before argument on their case has been heard, and the eloquence of the advocates of this system of locomotives is apt to leave the inquirer with a similar bias to that which the administrators of justice are apt to have after the counsel for the plaintiff has been heard. Probably many of those who attended the Master Mechanics' Convention last June, after hearing the report and the discussion on the subject of this article, were also left in the perplexed state of mind that jurors are sometimes in after counsel for the defense has knocked down the arguments and thrown doubt on the evidence of the other side. Unfortunately thus far no competent judge has summed up the case of compound *versus* simple locomotives, so that all of us who are interested in the subject are compelled to browse among the rather sparse facts and evidence which is accessible, and draw such conclusions as we can, or keep our minds blank until such time as the light will be clearer.

To most sincere inquirers for information the report of the Committee of the Master Mechanics' Association on this subject, we think, must have been disappointing. Its inconclusiveness leaves the question very nearly where it was before they made their elaborate tests. The main questions, after all, are the amount of saving of fuel which can be effected by the compound system, and the efficiency of the engines—and by the latter we mean the amount of work which can be done by them—or, in other words, the number of cars hauled per train and the number of miles run per year.

It seems as though decisive testimony could be obtained with reference to these important points with much less elaborate tests than the Committee undertook. In fact, the Committee seems to have been almost overwhelmed by the excessive elaborations of their own experiments. The real questions which a railroad manager wants answered in order to determine whether it would be best to get compound or simple engines for the traffic of his road are, first, whether the compounds will haul his trains and do it regularly without an excessive amount of failures, and, next, whether the saving in fuel will be materially greater than the addition to the cost of repairs and interest on first cost.

Now on nearly all roads there are a number of trains which run with a tolerable degree of regularity, and with a uniform number of cars. At any rate, with the co-operation of the transportation department the number of cars can usually be regulated during a period long enough to make conclusive tests. Now supposing that on such a road a run of this kind, of from 100 to 150 miles, with, say a freight train, was selected, on which the number of cars to be hauled by the experimental train could be regulated within certain limits. The question of most importance to the manager would be, How much coal will be burned by a compound engine and how much by a simple engine of like size and weight and under like conditions ? The question is not whether a heavy compound locomotive will haul more cars or do it with less fuel than a light simple machine, but it is, which of two machines of the same weight and with the same steam pressure will do the work most economically. Until this is decided indicators, dynamometers, pyrometers, calorimeters, etc., might be ignored and their use reserved to investigate the causes of the good or bad results obtained by the simpler tests. Having two such engines, let one of them begin by hauling a moderate-sized train on a given run, and appoint some careful and reliable person—two would be better to check off each other—to weigh the coal taken on the tender and that left on it at the end of the run. Also arrange to have the cars of each train weighed by an experienced weigh-master. Let the simple engine take such a train one day and the compound the same kind of a train, as near as possible, and on the same run the next. Gradually increase the loads hauled, until each engine has reached its limit of capacity. If the results of such a series of tests was made by careful engineers and firemen on each engine for, say, two weeks, and were then repeated for two weeks more and the men exchanged from the one engine to the other, the tests would show with a very considerable amount of conclusiveness which kind of locomotive was able to do the kind of work in which it was employed most economically, at least so far as fuel consumption and efficiency are concerned. After such facts were established it would be time to use indicators, pyrometers, calorimeters, dynamometers, and other scientific instru-

ments to ascertain the causes which led to the results thus obtained.

Of course in making such tests, in order to arrive at any reliable conclusions, both engines should have fair play. It is to be presumed that the inventors, builders, and advocates of the compound system will do all in their power to obtain the very best results from it, and it is of course right that they should; but there is reason for believing that in some of the comparative tests which have been made the simple engines have had no equally intelligent and zealous advocates and friends.

The performance of new compound locomotives with every appliance that ingenuity, skill, and experience can suggest have been worked in competition with old simple engines which were friendless. After all has been said in favor of the compound, it still remains that the simple system has some advantages over the compound, as is indicated by their respective names. Ever since machinery has been used *simplicity* has been regarded as an advantage, and it is only when some very important advantage can be obtained by complexity that it becomes economical.

All the systems of compound locomotives thus far proposed involve a material addition to their weight. To the extent to which the weight is increased by compounding it is a disadvantage, and it is no more than fair that the simple system, in a comparative test, should have the advantage which might be derived from a similar increase in weight. If the boiler of a simple engine can be made larger to the extent of several thousand pounds of weight, it will have very much the same influence on its economy that the diminished demand for steam has on the compound boiler. This is an advantage which may legitimately be claimed for the simple system.

All compound locomotives must have either larger cylinders or more of them, and some other additional parts which will be certain to cost more to maintain than the smaller and simpler mechanism of the old-fashioned machines. How much or how little this increase will be probably only a considerable number of years' experience will tell.

There is, too, a perpetual amount which must be charged to the compound system, on account of the increased cost of the engines. This has been roughly estimated at about $750. It is probably more in some cases and less in others. Ten per cent. should be allowed on this annually for interest and renewals, which gives a yearly charge of $75 against the compound engines.

In their favor it must of course be admitted that there is a saving in fuel. How much is this? is the question which all who are interested in locomotive performance have been eagerly asking. The Master Mechanics' Committee give as the result of their test a final figure of 7.6 per cent., but add that the series of tests which represent most nearly the *average* monthly or yearly economy to be derived from compound engines show a saving of 16.9 per cent. of coal and 14.1 per cent. of water. These taken in connection with others, but notably the results of three months' work on the Northern Railroad of France —a report of which was published in the JOURNAL of last month—and which showed an economy of 14.45 per cent., lead to the inference that it would be safe to accept 15 per cent. as the average saving in fuel by the compound system of locomotives. It is not certain though that this might not be reduced if the simple engine was given all the advantages which might rightly be claimed for it.

On this basis Mr. Leeds, Superintendent of Machinery of the Louisville & Nashville road, during the discussion at the recent meeting of the Master Mechanics' Association, summed up the argument for and against compound engines for his line very concisely by saying that his engines burn about $1,800 worth of coal per year. A saving of 15 per cent. on this amounts to $270. Deducting the interest and maintenance charge of $75 leaves a net economy of $195. If we represent the unknown extra cost of repairs for compound engines at x, then we would have $\$195 - x =$ the net saving for the compound engines on that line. On the Louisville & Nashville line, however, coal costs somewhat less than $1 per ton. If the calculation was made for a line whose coal costs, say, $5 per ton, then the net saving would be $= \$1,275 - x$, or on the Central Pacific and other lines, where it costs over $10, the saving would be $= \$2,625 - x$. It may and probably will appear then that while the compound system may be economical on roads on which coal is dear, it may not be on those on which fuel is cheap.

The question whether compound locomotives will do as much work—that is, pull as heavy trains and run as many miles, on an average, in a year, is, however, a very important one. A horse which is often sick and thus unfitted for work when he is needed is a much less valuable beast than one which can work every day. Continuous and unremitting capacity for doing work is of much greater importance in locomotives than in horses. When a road is crowded with traffic and with an insufficient equipment it is of the utmost importance that its engines should be able to work without ceasing. The machine which will turn up ready for service at all times is the one which will be preferred, even though it is not as economical in fuel as some others, but which have delicate constitutions.

Then, too, the loads which can be hauled is a very important matter, as a very great saving results from an increase of train loads when there is a heavy traffic. This has been explained very often, but a few figures to show it anew will not be amiss here.

On the Lake Shore road last year the cost of fuel for locomotives amounted to 4.76 per cent. of the earnings. The cost of locomotive service was 6.51 per cent., and of freight-train service 3.17, or a total for both kinds of service of 9.68. An increase of train loads would add little or nothing to this latter item of expense. An increase of 10 per cent. in the train loads would therefore effect a saving of 0.968 per cent. If the fuel consumed was increased in like proportion it would amount to only 0.317, so that there would be a net saving of .651 per cent. It will be seen then that it would be economical to increase the weight of the trains, even though the fuel consumed was increased in even a greater proportion than the loads hauled. It is therefore of the utmost importance to know whether compound engines can haul as heavy trains as simple engines of the same weight, and therefore it is to be hoped that the able Committee which has been appointed to report on this subject next year will take some steps to throw light on this branch of the subject.

There is one kind of service in which undoubtedly compound locomotives may be expected to show a much greater economy of fuel than 15 per cent. We refer to service on heavy and long grades. For pushing engines the compound system ought to have very much greater advantages than for ordinary service.

RAILROAD STATISTICS.

At different times reference has been made to the methods by which railroad statistics are collected, and the difficulty of obtaining general figures in relation to the roads of the country. The Interstate Commerce Commission has undertaken to remedy this in part, and the report of its Statistician presents some valuable figures. The recent publication of *Poor's Manual* gives us, according to the usual custom of its publishers, an Introduction containing figures for a year later than those given in the Interstate report. The statements given in the *Manual* cover very nearly all the railroads in the country; the year is not uniform, different companies closing their fiscal years at different periods, but the totals given must approximate very nearly to correctness.

According to the *Manual* there was, at the close of 1891, a total of 170,601 miles of railroad in the United States, being an increase of 3,898 miles during the year. The mileage of the roads reporting their earnings, etc., was 164,262 miles, and on these lines there were in use 34,022 locomotives; 24,497 passenger and 7,368 baggage, mail and express cars; and 1,110,304 freight cars.

This property was represented by $4,809,176,651 capital stock; $5,235,295,074 funded debt; and $345,362,503 other debt. The last item, perhaps, does not exactly represent the real debt, as a large part of it consists of balances of accounts and similar matters.

The result of the operations of these roads was:

	1891.	1890.
Gross traffic earnings	$1,138,024,459	$1,097,847,428
Working expenses	781,814,579	750,926,110
Net traffic earnings	$356,209,880	$346,921,318
Interest paid	231,259,810	226,799,682
Dividends paid	90,719,757	85,075,705

The average interest paid, including all debt, was 4.10 per cent., and the average dividend on stock was 1.85 per cent.

The average mile of road earned last year $6,926 gross and $2,168 net. Of the total earnings passenger traffic contributed 25 84 per cent., freight 67 and other traffic 7.16 per cent. The average passenger train earned 90.7 cents and the average freight train 152.8 cents per train mile.

The total traffic reported for the year was:

Passenger train mileage	320,712,013
Freight train mileage	493,541,969
Mixed train mileage	16,948,394
Total revenue train mileage	831,202,376
Passengers carried	556,015,802
Passenger—mileage	13,316,925,239
Tons freight moved	704,398,609
Tons freight moved one mile	81,210,154,523

From this it would appear that the average passenger journey was 23.95 miles, and the average freight haul was 115.29 miles. For the first time in a number of years there was a slight increase in the average rates, which for three years past have been:

	1891.	1890.	1889.
Rate per passenger-mile	2.184 cts.	2.174 cts.	2.169 cts.
Rate per ton-mile	0.929 "	0.927 "	0.970 "

The figures indicate that the year was, on the whole, a fairly prosperous one for the railroads.

NEW PUBLICATIONS.

The Memphis Bridge—A Correction.

In our issue for July it was stated that Mr. George S. Morison, Chief Engineer of the Memphis Bridge, had issued an "album containing a number of sheets showing the general plan and much of the detailed work of the different spans of the bridge." We are requested by Mr. Morison to say that what we spoke of as an album was merely a set of the lithographic plans stitched up by themselves, these being taken from some of the plans which were made for use during construction, and were left over on the completion of the bridge. As he has had various inquiries asking where the album could be obtained, he has requested us to say that none was published.

Rare and Useful Information for Travelers, Mechanics and Railroad Men. Compiled by T. J. Nicholl, C. E. Chicago, Ill.; Danks & Company.

This is a little book of 72 pages and of size to be carried in the pocket, which contains a quantity of miscellaneous information on all sorts of subjects, railroad statistics, accidents, business law, speed of trains and a variety of other things, with a number of tables thrown in apparently to fill out the size of the book. Like most books of the kind it has something in it which is useful, but the tables can nearly all be found in any standard handbook, and it is somewhat difficult to understand the plan or principle upon which the book has been put together. A traveler, however, may find it handy.

The Log of the "Savannah." By J. Elfreth Watkins, Curator of the Section of Transportation of the United States National Museum. Washington; published by the Smithsonian Institution.

This is a reprint of the log of the *Savannah*, which was the first steamship to cross the Atlantic, and it is accompanied by a quantity of information in relation to the steamer, her construction and her cruise across the ocean. It is illustrated by several drawings and photographs. Mr. Watkins has done a service in thus preserving and putting into shape an authentic record, with the evidence connected with this noted voyage, in an accessible form.

Venezuela. *Bulletin No.* 34. Washington; issued by the Bureau of American Republics, W. E. Curtis, Director.

This is another one of the very useful and convenient monographs on the different South American countries, which have been from time to time issued by the Bureau of the American Republics in pursuance of its general plan for promoting the knowledge of those countries and intercourse with them. It is arranged on the same plan as the others, to which reference has heretofore been made, and has some excellent illustrations. Venezuela is a country of great natural resources, but is even less known in the United States than others of its sister republics, and the present volume will be of service.

The History of the Band-Saw. By W. Samuel Worssam, Engineer. London, England; printed for the Author.

Histories of special tools are not common, though in many cases they might be made interesting. Indeed, Mr. Worssam says in his preface:

> No previous account has appeared of the origin of the band-saw and of the progress and development it has made up to the present day. This work is the outcome of my experience, dating from the practical introduction of this interesting type of saw into this country, and of a personal knowledge of several of the inventors who are referred to.

The book includes a historical account of the first introduction and subsequent progress of the band-saw; descriptions of the machines devised for its use for various purposes; an account of its manufacture and of the various methods of using it. While Mr. Worssam is, of course, most familiar with English practice, he does not neglect that of other countries, especially of the United States, where wood-working machinery has had

its greatest development. While this little book is chiefly interesting to wood-workers, it is readable for any one who takes an interest in industrial progress.

COMMERCIAL INFORMATION CONCERNING THE AMERICAN REPUBLICS AND COLONIES. 1891. Washington; Bureau of the American Republics.

This is Bulletin No. 41 of the Bureau of the American Republics, and contains a large amount of recent information concerning changes in tariffs, shipping lines, mails and similar matters, besides late statistics of imports and exports, in the Argentine Republic, Colombia, Venezuela, Mexico and other countries. It is issued in pursuance of the general plan of the Bureau, to disseminate commercial information as widely as possible and to promote commercial intercourse between this and the other American countries.

RULES AND INSTRUCTIONS FOR THE GOVERNMENT OF EMPLOYÉS OF THE DEPARTMENT OF MAINTENANCE OF WAY AND OF BRIDGES AND BUILDINGS ADOPTED BY THE SOUTHERN PACIFIC COMPANY, ATLANTIC SYSTEM AND ITS CONTROLLED LINES. J. Kruitschnitt, General Manager. Houston, Tex.; published by the Company.

In this little book, which is issued for the information of its employés, the Southern Pacific Company gives a well-considered and carefully prepared set of rules for the government of the men employed in its track and bridge work. The rules have apparently been carefully revised to meet the demands of practice, and are generally expressed in a clear and direct way. In order to make them clearer still, they are accompanied by a number of plates showing the standard sections of road-bed, the standard rail-joints, frogs, switches, etc., adopted by the Company.

A full criticism would be impossible without taking up the rules one by one, but in a general way it may be said that they seem to fill the requirements of such a system of orders in a very satisfactory way. It is of great importance that rules for the government of railroad employés should be fully enforced. It is also of importance that they should be such as the employés can clearly understand, and that they do not include any that are difficult or impossible to be carried out. Requirements that cannot be enforced tend to bring the whole system into contempt and should not be allowed to exist. A certain degree of flexibility is always necessary, but this can well and properly be provided for in the rules themselves.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING. By A. M. Wellington, W. B. D. Penneman and Charles W. Baker. New York; The *Engineering News* Publishing Company.

This is a book of some 300 pages and 77 illustrations, and is a reprint of a series of papers published in *Engineering News*, which were intended to be an investigation into the comparative cost, safety, light-giving power and general advantages of oil lamps, compressed gas, gasoline carburetters and electric lighting for the illumination of passenger cars. The investigation has apparently been made with considerable care, and with the desire to be as impartial as possible as to the merits of different systems. The book includes descriptions of different systems of lighting; an investigation into the comparative photometric value of different lights; the comparative cost of plants and the comparative safety of different systems in cases of accident. It is perhaps the first attempt at a systematic consideration of the subject, and is really worthy of reading and consideration by railroad managers who have the decision of lighting questions.

The small size of the book, adopted for some unknown reason, is open to the objection that nearly all the plates and some of the tables have had to be put upon folding insets, which are always a nuisance to a reader. Most of the illustrations are good, but a larger page would have allowed them to come in their proper place on the pages and would have been a very great improvement.

MANUAL OF THE RAILROADS OF THE UNITED STATES FOR 1892. By Henry V. Poor. New York; H. V. & H. W. Poor.

But little that is new can be said of this volume, which is the 25th annual number of the well-known *Poor's Manual*, which many years ago became a standard book with all who are interested in railroads. No change has been made in its form beyond the necessary increase in size which comes from year to year. It is the only work of the kind which we have, and upon it investors and others must rely absolutely for information. Of course errors will creep in occasionally, but we believe that very great pains are taken to make the book as correct as possible, and its thoroughness and reliability are its great merits.

Some reference to the introduction to the *Manual* will be found on another page.

DYNAMOMETERS AND THE MEASUREMENT OF POWER. *A Treatise on the Construction and Application of Dynamometers; with a Description of the Methods and Apparatus Employed in Measuring Water Power.* By John J. Flather, Ph.B., M.M.E., New York: John Wiley & Sons.

The title of this book is sufficiently descriptive to give a general idea of its character. It contains six chapters on the Determination of Driving Power; Friction Brakes; Absorption-Dynamometers; Transmission-Dynamometers; Power required to Drive Lathes, and the Measurement of Water Power. It contains 77 illustrations, mostly very neat outline engravings made by the wax process. It contains, however, a few execrable "half-tone" engravings, such as figs. 25 and 39. Such cuts as these often make one regret that the half-tone process was ever invented.

The book consists very largely of excellent descriptions of the various kinds of dynamometers which have been used by different experimenters. These are admirably clear, although the professional tendency to rush into mathematics unnecessarily often, it is thought, manifests itself all the way through the book. To illustrate what we mean, on page 3 it is said that "for a general rule, in ordinary machine work we may take roughly 1 H.P. as sufficient to drive machine tools necessary to keep ten men at work."

It would seem as though this statement was as clear as it is possible to make it. By way of explanation, however, it is added:

"Expressed algebraically, this rule of thumb would be

$$\frac{N}{10} = H.P.,$$

when N equals the number of men employed; or, if we let $10 = C$, a constant, we have

$$\frac{N}{H.P.} = C."$$

Now it is submitted that the explanation is harder to understand than the original proposition. If the author had a psychological dynamometer and could measure the amount of cerebral energy which the reader must expend to understand his first proposition, and that exerted in following the mathematical elucidation, we feel sure that more units of phosphorus would be consumed in the latter exercise than in the former.

The book, however, is good in so many ways, so conveniently arranged and so clearly written as to deserve very high com-

mendation, and it is destined to become a standard of reference on the subjects to which it relates.

The printing and mechanical work is generally very good. It has one fault, however, very common in American books. The sheets are tightly stitched together, so that it will not open readily. To add to the discomfort in reading it, the margin is comparatively narrow, particularly the inside one. A quarter of an inch more margin on the inside would have added greatly to the comfort of the reader.

Street Railways; their Construction, Operation and Maintenance. A Practical Handbook for Street Railway Men. By C. B. Fairchild. New York; the Street Railway Publishing Company. Price, $4.

There have been treatises on street railroads or tramways, but none recently, and this class of roads has received so rapid a development, both in extent and methods of operation, within a few years past that a new treatise had become a necessity. Mr. Fairchild has undertaken to fill this vacancy, and has done it with a very considerable degree of success. In his preface he modestly disclaims any intention of making a complete or exhaustive work, but says that he has desired only to present in convenient form as many facts as possible bearing upon the street railroad industry, and to embody and present the results of experience brought as closely as possible up to date. A considerable part of the book has been published in serial form in the *Street Railway Journal*, but it has been revised in bringing it into book form. The extent of the subject can be best seen by the titles of the chapters, which are on Electric Traction; Cable Traction; Horse Traction; Steam, Air and Gas Motors; Inclined Planes; Rack-Rail Inclines; Elevated Roads; Car Building; Track Construction; Discipline and Rules; Franchises, Stocks and Bonds; Book-keeping and Accounts; Leading Types of Cars and Auxiliary Appliances. The great development of electric traction is very well treated and much space is given to electric appliances, but the cable road and other systems are not neglected. The chapters on Rules and on Operating are of a practical kind, and the author has given accounts of the best methods of management and those which have been approved in practice.

Upon the whole Mr. Fairchild has made a very good book, and one which will meet a decided want. It is very fully illustrated, although exception might be taken to the quality of some of the engravings. This is a minor fault, however, and it is better to have abundant illustration in a book of this kind, since the engravings help very much to an understanding of the text in description of machinery and appliances.

The book has a large-sized page, permitting the use of large engravings without the use of folding insets, which is an excellent feature. It can be recommended to all who are interested in street railroads and their methods.

Elements of Machine Design. *Notes and Plates for the Use of Students in Lehigh University.* By J. F. Klein, Professor of Mechanical Engineering. Second and Revised Edition, 1892. Bethlehem, Pa.; the Moravian Publishing House.

This is a nicely edited work, printed in large type on good paper, and illustrated with large folding plates. Its sphere of usefulness, however, appears to be limited to the use of the students at Lehigh University, as is stated in the title-page, and outside of that we find little in the work, as a whole, to recommend it for general reference.

Probably the students have a general course of study into which this work would admirably fit, but most of its chapters do not go deep enough into the subject-matter for the use of the engineer in his office, unless he be particularly well posted; and, if this is the case, then he would probably not have need for this particular work.

It belongs to that class of literature which abounds in the library of the mechanical engineer, and which is particularly dangerous from the fact that the work is not complete in itself; at least, that is true of nearly all its chapters. In working up any design this book would only assist one who had other works of reference, except in the few particulars of small dimensions, and if the book were limited to this use alone it could be made about one-third its size, and therefore much handier to use and easier to refer to.

The work appears to have been carefully compiled, and is as free from typographical errors as any book of this kind can be. Most of the illustrations explain themselves, but fig. 9, page 10, is difficult to understand from the text, and should have been accompanied by a drawing in plan. The subject of boiler thicknesses for strength is touched upon, but is left incomplete. The thickness of flues to withstand collapsing pressure is also studied, but the formula given is too complicated for practical use, and a much simpler one is always adopted.

In fact, if the work is to be useful as an assistant to the designing engineer these approximate formulas should always be given, as they will probably always be used in preference to any that may be more exact, but which are difficult to apply. Again, a chapter on riveting is given at some length, but to study the subject at all one must refer to other books. The proportions for rivets appear good as far as they go, but they do not go far enough. For instance, in boiler work rivets are selected more with reference to a tight joint, and when this is accomplished the rivets will be large enough. Therefore it seems to us that a table giving the average proportions of rivets as used to-day for different thicknesses of plate would have been much better than the discussion as published.

Again, under fastenings for boiler-heads it would have been well to have called attention to the fact that the styles, as represented in fig. 4 and fig. 6, are best adapted for machine riveting, and that is the chief reason why they are so largely used. It would have been well also to have stated the advantages and disadvantages of the conical and snap-shaped rivet heads, as long as the subject is touched upon at all.

The chapters on Gears and Gearing contain some good information, especially on the advantages to be derived from using involute teeth, but we think it would be difficult to design teeth for a given wheel from this work alone; and yet the space given to the subject is sufficient to cover all ordinary cases that occur in practice. Under the subject of belts many formulas are given, but belts, especially leather and rubber ones, are always proportioned by much simpler methods. The same is true of line shafting. While it is always well to explain the theoretical side of these questions, we still think that the practical methods should always be given, as they are the ones to be used in every-day work, and when a special case arises which calls for greater refinement, other works are at hand which treat exhaustively of that particular question.

The book is full of good references to other authorities, and this practice should be encouraged. The tables of ordinates at the end of the book for laying out the profiles of teeth are good, and easily applied when one understands them.

TRADE CATALOGUES.

Grant's Gear Book for 1892. *The Lexington Gear Works, Lexington, Mass.*

This book, while of course primarily intended to advertise the work done at the Lexington Gear Works, contains some excellent hints on the drawing of gear-wheels, both spur and bevel, and some discussion on the best form of teeth. It also contains a list of a great variety and number of sizes of gear-wheels made by the Works. A copy will certainly be convenient for any one who has occasion to use gearing of any description.

Manilla Rope Power Transmission as Applied by the Link Belt Machinery Company, Chicago.

Rope driving is not new, having been in use for a number of years, more perhaps in England and in European countries than in the United States. Lately, however, the use of rope for the transmission of power instead of leather belts or line shafting has commanded increased attention from engineers and manufacturers. The advantages of this method of transmission and the different ways of applying are well set out in this pamphlet, which contains also illustrations of a number of places where it has been applied. The Link Belt Company is prepared to make plans and estimates for transmitting any amount of power in this way.

Contractors' Earth-Moving Implements and Road Machines. The F. C. Austin Manufacturing Company, Chicago, Ill.

This handsome catalogue contains an illustrated description of the Austin Company's "New Era" grader and ditcher; the Austin dump wagon and the Austin reversible road machine and road roller, together with some other machinery manufactured by the Company, including their street sweeper, their stone-breaking machine for road purposes, their well-borer and their portable engine. The merits of the New Era grader and the road machine are very well known by the large number of engineers and contractors who have used them, or have seen their work, and but little needs to be said about them. The catalogue has something more than the mere description, for it gives some valuable hints on the best methods of using excavating machinery and of moving earth, and also some information on road making. The illustrations are very good of their kind, being well adapted to show the machinery and the manner of using it. Every engineer on construction work and every contractor would find a copy of this catalogue useful.

CURRENT READING.

In GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for August there is the usual variety of short, pithy articles, treating of River Valleys; the Yellow River; End Towns of the World; the Tehuantepec Inter-Oceanic Route; China and the Tea Trade; the Landfall of Columbus, and a variety of other topics. It must not be supposed that this magazine is for teachers or geographical specialists only; almost every intelligent reader can find something of interest in its pages.

Among the books in preparation by John Wiley & Sons, New York, is a TEXT-BOOK ON EXPERIMENTAL ENGINEERING, by Professor Rolla C. Carpenter, of Cornell University.

The August number of the ARENA was largely given up to women, and the September number continues the free discussion for which this magazine is noted. Both sides of the present political discussion are ably presented in its pages.

The ENGINEERING MAGAZINE for August has papers on Compressed Air for Street Cars, by General Herman Haupt; the Mississippi Problem, by C. N. Dutton and H. St. L. Coppée; Ornament in Architecture, by L. H. Sullivan; Underground Water in Arid Regions, by R. T. Hill; River Improvement at Portland, by G. W. Freeman; the Railroad of the Future, by Oberlin Smith; Gold Mining in the Black Hills, by H. M. Hanson; Practical Hints on House Heating, by L. Allen; Evolution of the Constructive Faculty, by J. M. Burnett. The special departments continue to improve.

Recent numbers of HARPER'S WEEKLY have given illustrated accounts of the progress of work on the Exposition at Chicago, an account of the Sault Ste. Marie Canal and other papers of value.

The first article in GOOD ROADS for August is on the Demand for Better Roads, by Colonel J. A. Price. Other papers are on Cost of Labor; Convict Labor; Brick Pavement and a continuation of the series on Dirt Roads and Gravel Roads. The number is a very good one.

In OUTING for August there are a number of bright, seasonable papers, making it an excellent number for summer reading. The illustrations are very good.

The August number of the ECLECTIC MAGAZINE is very good reading also, and the selection of articles from English periodicals has been judiciously made.

The September number of SCRIBNER'S MAGAZINE has articles on Buffalo Hunting, on the Pueblo Indians, on St. Petersburg and its chief street, on the Greely Expedition, and on the future of the Tilden trust. Besides these there are several stories and lighter articles.

The POPULAR SCIENCE MONTHLY for September describes the work done in the Marine Laboratory at Wood's Holl; it has a Study of Involuntary Movements, by Professor Jastrow; a paper on Infectious Diseases, by Surgeon Sternberg, of the Army, besides several other papers of much interest.

A complete and handsomely illustrated description of the Farallon Islands is the leading article in the OVERLAND MONTHLY for September. Other articles describe the Redwoods of Northern California, and give an interesting chapter of War history never before published.

The September number of HARPER'S MAGAZINE is fully up to the standard both in text and illustrations, and furnishes much solid reading, besides lighter and more entertaining matter.

BOOKS RECEIVED.

A Memorial to Congress on the Subject of a Comprehensive Exhibit of Roads, their Construction and Maintenance at the World's Columbian Exposition. Boston; Albert A. Pope.

Dynamometers and the Measurement of Power: A Treatise on the Construction and Application of Dynamometers. By Professor John J. Flather, Purdue University. New York; John Wiley & Sons. Price, $2.

Administration Report on the Railways of India for 1891–92. By Lieutenant-Colonel R. A. Sargeaunt, R.E., Director-General of Railways. Simla, India; Government Printing Office.

The Carolo-Wilhelmina Ducal Technical High School at Brunswick: Programme for the Scholastic Year 1892–93. Brunswick, Germany; issued for the School.

Transactions of the Liverpool Engineering Society: Volume XIII. Edited by J. H. T. Turner, Honorary Secretary. Liverpool, England; published by the Society.

Census of Canada, 1891. *Bulletin No.* 12. *Manufactures in Cities, Towns and Villages.* Ottawa, Canada; issued by the Department of Agriculture.

Selected Papers of the Institution of Civil Engineers. Edited by James Forrest, Secretary. London, England; published by the Institution. The present installment includes a number of papers by different members, and an abstract of recent papers in foreign transactions and periodicals.

Annals of the Society of Italian Engineers and Architects. Seventh Year, 1892; *Volume III.* Rome, Italy; published for the Society.

Some Moral Factors in the Engineer's Career. By Alfred R. Wolff, M.E. This is a reprint of an address delivered at the Commencement of the Stevens Institute of Technology.

SOME CURRENT NOTES.

THE great tunnel for the water-power works at Niagara Falls is now nearly completed, the Cataract Construction Company reporting 7,600 ft. finished. This tunnel, it may be noted, is 19 ft. in width and 21 ft. high in the center, and is lined with brick throughout. It is now expected that the first mills in connection with the water-power will be in operation early in 1893.

THE CARAVEL "SANTA MARIA."

THE American Iron & Steel Association reports, from the statistics furnished to it by the manufacturers, that the total production of pig iron in the United States in the first half of 1892 was 4,799,056 gross tons, against 4,911,763 tons in the second half of 1891, a decrease of 112,707 tons. Adding the production of the two half years, we have the extraordinary production of 9,710,819 gross tons in twelve months, which is 508,116 tons in excess of the production of 9,202,703 tons in 1890. Our production of pig iron in the twelve months of 1891 fell below that of 1890 because of the serious interruption to furnace activity in the first half of 1891, when we made only 3,368,107 gross tons, the total production in that year being 8,279 870 gross tons.

THE production of Bessemer steel ingots in the United States in the first half of 1892, as reported to the American Iron & Steel Association, was 2,305,999 net tons, as against 1,599,096 net tons in the first half and 2,038,011 tons in the second half of 1891. The increase this year over the corresponding period in 1891 was thus no less than 706,903 tons, or 44 per cent.

The production of steel rails in the first half of the present year was 865,128 tons ; an increase of 285,199 tons, or 49 per cent. over the first half of 1891, and an increase of 13 per cent. over the second half of last year.

WHEN the Broad Street Station of the Pennsylvania Railroad in Philadelphia was built, the company believed that it would serve its purpose for many years to come. Already, however, it has become too small to accommodate the increasing travel, and work has begun on its enlargement. According to the plans there will be a ten-story building erected at the corner of Broad and Market streets, 200 ft. high, running 50 ft. west of Fifteenth Street. The total dimensions of the depot, when completed, will be 306 × 212 ft. The train shed will be the largest known, 598 ft. 8½ in. long, and with a span of 304 ft. The order for the iron and steel is the largest of the kind ever given out in Philadelphia, and will require fully 10,000 tons of plates, girders, etc. It is expected that all the additions and alterations will be made before the opening of the World's Fair next spring.

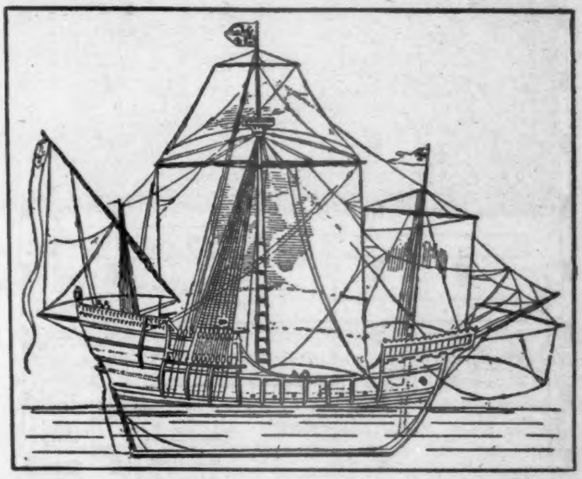
THE Highway Commission appointed under the new Road Law of Massachusetts has begun its work by asking for information from the town and city authorities throughout the State. The present object is to ascertain the methods followed, the authorities having charge of the roads, the cost of maintenance, the general condition and other particulars. Upon the information collected the Commission will base a report to the Legislature, which is expected to include practical recommendations for a general highway law.

THE caravel *Santa Maria*, built in Spain and as nearly as possible a reproduction of the ship in which Columbus made his voyage in 1492, sailed from the port of Palos, August 3, on the four hundredth anniversary of the beginning of the original voyage. The sailing was accompanied by appropriate ceremonies. Under the convoy of a Spanish war-ship the *Santa Maria* will repeat as nearly as possible the voyage of four hundred years ago.

The sketch given below shows the general appearance of the *Santa Maria*, which will be seen in this country in due season. The upper illustration (from *Engineering*) is from a photograph of the *Santa Maria* taken immediately after her launch. It may be added that she was built by the Spanish naval authorities, and that reproductions of her two consorts, the *Pinta* and the *Nina*, are now being built in Spain, at the expense of the United States.

THE contractors for the building of the proposed lighthouse on the Diamond Shoals off Cape Hatteras gave up the contract, as recently noted, the difficulties encountered being so great that even engineers of such experience and resources as Messrs. Anderson & Barr despaired of overcoming them. The Lighthouse Board, however, does not give up the project, and new plans for establishing the light are now being prepared.

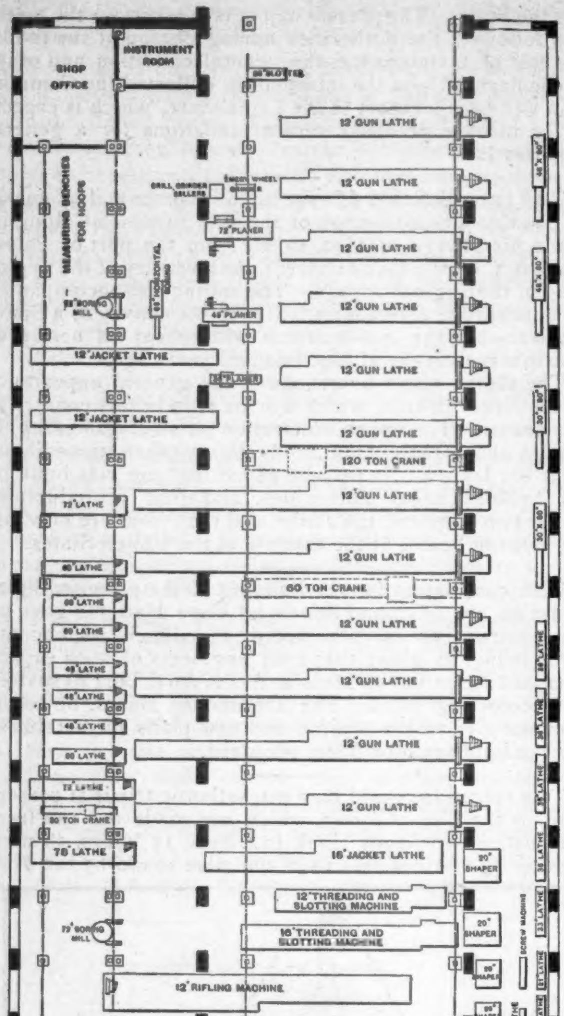
THE record for speed on a transatlantic trip is at present held by the *City of Paris*, which has made the run from Queenstown to Sandy Hook in 5 days, 15 hours, 58 minutes, or 33 minutes less than the time made by the *Teutonic* a year ago. The actual distance run by the log was 2,785 knots ; the best day's run was 520 knots, and for four consecutive days the ship made over 500 knots a day. The average speed for the entire voyage was 20 48 knots, and that of the best day 21.67 knots an hour.



THE CARAVEL "SANTA MARIA."

THE WATERVLIET GUN-SHOP.

THE accompanying illustration, from the *Iron Age*, is a plan of the new south wing of the gun-shops at the Watervliet Arsenal, showing the arrangement of the machinery in this wing. It corresponds to the north wing built some time ago, but has not the same width, being 400 × 154 ft. in size. With the central building the total length of the gun-shop is now 958 ft. The central building contains the forges, shrinkage pit, boiler and engine-room. The plan of the south wing given conveys a comprehensive idea of the tools which will eventually occupy it, a number of which are already under construction. When they



THE SOUTH WING OF THE WATERVLIET GUN SHOPS

are completed the shop will be in condition to handle without difficulty guns of the largest size yet designed by the Ordnance Department.

The eastern extension of the south wing is 22 ft. wide and the western extension 50 ft. The central portion is 76 ft. between the walls and 60 ft. from center to center of the columns carrying the cranes. The height from the floor line to the peak of the roof is 75 ft. Except at the central or shrinkage-pit section, which has a monitor roof, the entire building is lighted from the sides and ends, and we may here state that it is one of the best lighted shops we ever entered.

At the present time there are three boilers and one 250 H.P. Fitchburg engine furnishing power for the north wing. When the boiler and engine-rooms were designed space was provided for the engines and boilers necessary to run the south wing.

The crane track in the north wing is 50 ft. wide, and on it travel two 30-ton square-shaft cranes ; the track in the other wing is 60 ft. wide and upon it are two Morgan electric cranes, one of 60 tons and the other of 120 tons capacity. At the shrinkage pit the two tracks have been extended past each other, so that the cranes from either wing can be brought into service handling guns at that point.

A RAPID STEAM CRANE.

THE accompanying engraving is from a photograph of one of three steam-power cranes built by the Detroit Foundry Equipment Company, Detroit, Mich., and placed on the steamer *Pioneer*, built for the Cliffs Iron Company, of Cleveland, O., by the Detroit Dry Dock Company. These cranes were specially designed for loading and unloading pig iron, and are very rapid in their work. The motive power, it will be seen, consists of a double upright steam-engine acting on the shaft which carries the spur gear. Both the hoisting and the revolving are done by steam power, and the crane is very easily and quickly controlled. The whole construction is so well shown in the engraving that but little description is needed. In use they have given full satisfaction.

The steam crane of this class is something of a novelty on the lakes, the *Pioneer* being the first steamer to be supplied with them. It is evident that they must be a very useful addition to a ship's equipment, as they can be of great use not only in loading and unloading, but also in lightening cargo in case of accident by running aground. The lake shipowners have shown themselves usually very apt to adopt improvements, and the use of these quick-working steam cranes seems to be one which will commend itself to them.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.*

CHEMICAL METHODS.—INTRODUCTORY.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

IT is proposed to give, in a series of articles in this JOURNAL, of which this is the first, the chemical methods in use in the Laboratory of the Pennsylvania Railroad. These methods are a part of the official specifications on which materials are bought, and, of course, like specifications, are subject to revision and modification from time to time as new knowledge develops. It is hardly necessary to say that the appearance of these methods in this JOURNAL is simply for public information, and that the road is not at all bound by what appears in this JOURNAL. It is intended that the methods as they appear from time to time shall correspond exactly with the state of affairs at the time, but it frequently happens that slight changes or modifications are introduced in the official copy of specifications or methods that could not be made after the article has once appeared in this series, so that those whose interests are affected must be guided by an official copy obtained in the proper way.

There are a number of reasons why it has been decided to make public the chemical methods in use in the Pennsylvania Railroad Laboratory, and to make these methods a part of the specifications.

First, the specification attempts to tell the manufacturer what is wanted. It is therefore simply fair that the manufacturer of any product should know what tests the material is going to be subjected to, and exactly how the tests are to be applied. It is hoped to make the publication of

* The first series of these articles was published in the RAILROAD AND ENGINEERING JOURNAL, December, 1889–June, 1892. The present article is the first of a second series.

STEAM DERRICK FOR STEAMER "PIONEER."

BUILT BY THE DETROIT FOUNDRY EQUIPMENT COMPANY.

the methods sufficiently minute and definite, so that any one possessing good chemical training will be able to use the methods exactly as they are used in the Pennsylvania Railroad Laboratory, and get corresponding results. Illustrations of apparatus will be given where it is thought they can throw any light on the method.

A *second* reason for giving the methods is the avoidance of disputes. It is well recognized by those who are constantly using the results of chemical analyses that different chemists differ somewhat in their analysis of the same product. There are believed to be four causes for discrepancy in chemical analyses. These four causes are as follows :

First, the sample worked on by the two chemists is not the same. This is a frequent cause of discrepancy in chemical analyses. We have many times been met with discordant statements as to what a certain lot of material shows on analysis. On investigation we often find that the material in question is a carload consisting of, say, 50 to 75 barrels, and that the two or more chemists had not obtained their sample from the same barrel. If we may trust our experience, it is a very common error for manufacturers and many times consumers to suppose that because a certain amount of material was shipped in one car, or even in one barrel, that therefore the material is uniform. It is well recognized that the obtaining of a uniform sample is one of the uncertainties that must necessarily attend all commercial products. It has been previously stated that by design we take a sample from a single package, and that one sample must represent the shipment. It follows, therefore, that if there is a discrepancy between two chemists in examining the same lot or shipment of material, this discrepancy may be due to difference in the samples on which the two chemists worked. This difficulty is not at all a serious one, since it is very simple to exchange samples. We have many times done this, and in all our regular routine work always retain a sample from a condemned shipment for two weeks, so that the party shipping the material can have a sample of the material which we worked on if he desires.

The *second* reason for discrepancy in analyses is impurities in the chemicals. Reagents marked "chemically pure" many times contain serious amounts of material that affect the analysis. Of course no chemist would ever think of making an analysis without checking up the chemicals used. This may be done apparently in two ways, either by a test of the chemicals to see that they do not contain injurious constituents, and second, by making a "dummy" analysis alongside of the real one, using in this dummy analysis the same amounts of all the chemicals as are used in the case of the real analysis, but without having any of the material to be examined present. Of course all the impurities found in the dummy analysis at the end are deducted from the result obtained in the real analysis. This method of making a dummy analysis is, of course, applicable in many cases. We are hardly

willing to say that we think it is a complete check on errors due to impurity of chemicals, since we do not know that in all cases the same reactions will take place with the chemicals alone that would take place if the substance to be analyzed was present. The best way, of course, is to have chemicals free from injurious substances. So far as difficulties arising from discrepancies between chemists due to this cause are concerned, there is no serious trouble in locating them. In test cases it is not at all uncommon for chemists to swap chemicals in cases of discrepancy, and these three things—namely, testing the chemicals, the dummy analysis, and the swapping of chemicals would, without doubt, locate the difficulty if it was due to impurities in the chemicals.

The *third* cause for discrepancy in chemical analyses is what may be embraced under the general heading of "poor manipulation." This is clearly a question of the skill and judgment of the chemist. Hundreds of illustrations might be given of how the manipulation affects the analysis. In filtering one chemist spills a few drops while another does not. Again, the method requires that the liquid shall be at a certain temperature. One chemist uses a thermometer, and the other guesses at it. Again, the method requires that a certain amount of a certain reagent shall be used. One chemist measures it, another guesses at it. Again, one chemist takes into account the impurities in the air or dust, and takes special means of keeping these out; another one ignores this little source of error, and so on. It is obvious that this might be a quite serious source of discrepancy between chemists, and there are those who think and state that this is the principal source. An old teacher of chemistry once said in our presence, "No chemist can make an absolutely accurate analysis. There are chemists who can work near enough to accuracy so that their work is valuable; there are others who cannot." As a means of overcoming the discrepancy due to lack of skill or what is commonly termed "manipulation," the two chemists who disagree, and who desire to find the cause of the difficulty, may get together and make an analysis each in the presence of the other. This is frequently done, especially in assaying. Many times it is not necessary to go as far as this. A talking over of the methods of procedure will usually locate the difficulty.

With regard to the above three sources of discrepancy in chemical analyses, it will be observed that there is no serious difficulty in finding the cause of the discrepancy and of making the analyses agree by finding this cause. This is not the case, however, with the method. A discrepancy in the results due to a difference in the method used is one that no amount of work or checking up of chemicals or interchange of samples will eliminate. The discrepancy is inherent. It is well recognized by those who are familiar with chemical work that a number of different methods may be made use of, or modifications may be introduced into a single method by different chemists, which will vary the result somewhat, and there is as yet no agreement, at least in this country, so far as we know between chemists, except in a limited degree among agricultural chemists, as to what method shall be regarded as standard and be used in case of dispute. As long as there is no such agreement it is very difficult to adjust these discrepancies due to method. Each chemist claims that the method he uses is as good, or perhaps better, than the other, and that the results he obtains are the correct ones. It is obvious that no amount of talk or discussion will bring such parties together, and it is this state of affairs that has led us to the idea of making the method a part of the specification. This, we think, will eliminate the *fourth* cause of discrepancy in chemical analyses.

There is still a third reason why we think it is advantageous to make the methods a part of the specification—namely, some of the methods which we use have not yet been put in print, which is due to the fact that we are examining commercial products which have not previously been much worked upon, and there are no methods among those published which are entirely applicable. We have a number of times had to devise methods for the examination of a new product. Parties desiring to check up our work, therefore, cannot look to any of the books or published methods for information as to how these products are examined.

It will, of course, be understood beforehand that there is no assumption of such superior knowledge or skill on our part as entitles us to dictate to the profession. We are trying to meet the difficulties which arise in our work in the best way we know how, and for this purpose make the method a part of the specification, and use such methods as in our judgment are best and most applicable to the work. It is well recognized by all chemists that there may be some methods better than others, but that the best methods are many times so long and laborious that they are inapplicable to such work as may be in hand. It may happen, therefore, that a method will be used that is not absolutely the best so far as extreme accuracy is concerned, but is near enough to accuracy for the purpose in hand, and has the additional advantage of being more rapid.

This use of methods not characterized by the highest possible degree of accuracy can introduce no difficulty, since by the plan which we pursue of making the method a part of the specification, we only require in the specification that the constituent in question shall conform to the limits shown by the method given. For example, suppose that the most accurate method known shows that a piece of steel contains 0.51 per cent. manganese, and that the method which we use shows this same piece of steel to contain 0.50 per cent. manganese. Here is an error of 0.01 per cent. of manganese, which proportionally would pervade all determinations of manganese made by our method. But our limitations are based on the determinations made by our method, and therefore, although this method might give results above or below the actual truth, it introduces no hardship.

It is, of course, essential that the method we employ shall be reliable and uniform in its indications—that is to say, a number of different analyses made of the same sample by this method must agree with each other within reasonable limits of error, or the method is worthless; and it will, of course, be our duty to take care that this point is covered in the methods given.

Among the advantages which we anticipate will result from giving publicity to the chemical methods which we use is the criticism of these methods, which will come as the necessary resultant of their publicity. Recognizing as we do that there is more or less uncertainty in all chemical methods, it is our sincere hope that sufficient criticism will be put upon the methods as they are put forth from time to time to check up any errors or flaws in them. The fact that a method is made a part of the specification and put in print should not in any sense prevent criticism of the method. A demonstrated error in the method will be accepted and recognized at once and modifications introduced. It is clear that such criticism on the part of other chemists, and modifications of methods which they may suggest, or which may come as the result of our own study, will have a tendency to develop chemical methods for the examination of commercial products which sooner or later can fairly be regarded as standard, and while we do not at all attempt to assume that such methods as we may put forth can now be regarded as standard in any other sense than as applying to the materials purchased under specifications of the Pennsylvania Railroad, it is our sincere hope that sufficient study and criticism will be put upon these methods as they appear from time to time by other chemists, so that sooner or later, and after a proper period of development, the profession will be willing to accept them as standard methods.

(TO BE CONTINUED.)

COMPOUND LOCOMOTIVES IN THE WORLD.

AT the session of the International Railroad Congress in Paris, in 1889, the Compound Locomotive was one of the questions submitted for discussion and report at the meeting of the Congress to be held at St. Petersburg dur-

ing the current year. The reporters to whom this question was assigned were MM. L. Parent, Chief Engineer of Motive Power of the French State Railroads, and Concanargues, Chief Assistant Engineer of Motive Power of the Paris, Lyons & Mediterranean Railroad.

These gentlemen have prepared an elaborate and interesting report, in which they have given a condensed account of the various types of compound locomotives thus far brought into use, and of the experience had with them in service. The general tenor of the report is well expressed in its closing paragraphs, which we give below:

CONCLUSION.

The advantages of the compound type are not yet proved to the satisfaction of all railroad engineers. Its partisans are indeed more numerous than the opponents, and the applications, as we have seen, have increased from 680 to 1,858 in less than three years. These figures may be analyzed as follows: Two-cylinder locomotives have increased from 522 to 1,371; three-cylinder from 99 to 108; four-cylinder from 59 to 379. This very great increase is certainly due in great part to the general increase of pressure carried in locomotive boilers, which requires either double expansion or better valve motions to utilize it. The majority in favor of the two-cylinder type remains strong, but in proportion the four-cylinder type has made the greatest progress, thanks to the very considerable aid furnished by America, which up to 1889 had paid little attention to this question, but reports already 123 in the figures above. The American engines with four cylinders are almost all of the type with the cylinders side by side, first proposed in France in 1882, but actually perfected and brought out in 1890 in the name of the Vauclain type.

The result obtained from trials of long continuance which are still too few, but which have been made carefully by different companies between simple and double-expansion locomotives differing only in the application of the compound principle, is that the double-expansion engine shows an economy in fuel of 8 per cent. at the least, when the pressure of steam is 125 lbs. only, without any considerable increase in the expenses of lubrication or

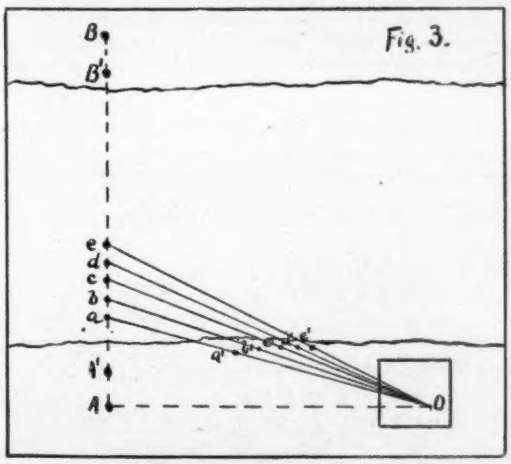


Fig. 3.

maintenance, at least when two cylinders only are used. This economy of fuel certainly increases with the increase in boiler pressure.

Our conclusion will not differ from that of the report presented to the third session.

"If in countries where coal is cheap, it is not of advantage to change ordinary locomotives into compound locomotives nor perhaps to build new compound locomotives at a moderate pressure, it is certainly of advantage in countries where fuel is dear to build new engines at high pressure on the compound principle, and even to change to compound the existing locomotives when the boilers are in condition to carry a high pressure."

The new discussion to which the examination of the compound question will give rise will probably permit us to decide, moreover, if it is preferable to use two, three, or four cylinders; if it is best to make use of automatic starting apparatus or not; and finally, if we approve of four-cylinder engines, what is the best arrangement of the cylinders to recommend.

We do not think that the question of the use of the triple-expansion locomotive can be usefully or advantageously taken up at this meeting.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

(*Continued from page* 364.)

DETERMINATION OF CROSS-SECTIONAL AREA.

The methods applied for the determination of the cross-sectional area and of the average velocity in a vertical vary according to the width of the river.

When the river is not very large—200 to 300 ft. in width—then a double cable or steel wire can be thrown across, and the observer, traveling along this cable or wire, can measure the depth of the water and its velocity at equally distant points (as shown by the cable or wire).

When the river is larger, say from 300 to 1,000 ft, in width, then the cable or wire can be still applied, but it should be supported by small boats held by means of anchors 200–300 ft. apart.

When the width of the river is more than 1,000 ft., then no cable or wire can be thrown across it, and the observer is obliged to travel in a boat across the river, following the line of cross-section laid down on the shores by means of posts, and to stop at some points by means of anchors. His position is then determined by means of some angle-measuring instrument.

Of course, it is very important for the facility of computations, that the measurements of depth and velocity be taken at equal intervals. It can be easily arranged so that the observer will travel in the cross-section line *A B*, fig. 3, and stop in the points *a, b, c, d* . . . . at the crossing of some previously fixed direction line. For this purpose it is enough to draw on the shore a base *A O*, say perpendicular to the cross-section *A B*, and in the point *O* fix the theodolite or the surveyor's table. Then the points *a, b, c, d* . . . . being designed on the topographic plan of the river at equal distances, it is not difficult to fix their positions by means of the surveyor's instruments, or by computing the angles *a O A, b o A, c o A*, ... This method requires two observers at once, one in the boat, the other at the point *O*. But the task of this second observer can be facilitated by driving posts on the shore, at the points *a', b', c'* . . . . in the direction of the lines *O a, O b, O c*, ... , and then putting a large post in the place of the instrument *O*. The required points *a, b, c*, ... will be then fixed as the cross points of the line *A A'* and of the directions *O a', O b', O c'* . . . . .

The measuring of the depth and velocity should be performed in calm weather, and the best vessel for that purpose is a kind of raft, a platform built on two boats 10 to 14 ft. apart, and retained by means of two anchors.

The measurement of depth is made by means of a wooden post for small depths, or by means of a leaden weight or log hung on a cable or wire.

For the measurement of velocity of water for depth under 15 ft., the best instrument is the hydrometric apparatus* of Woltmann, Baumgarten, or Amsler on an iron tubular rod; for depths more than 15 ft., the Amsler apparatus with electric signals, steel wire, or winch and special hoisting apparatus should be applied. In the latter case the apparatus is sunk on a wire by means of a winch placed in the center of the platform. Of course it should

* Moulinet.

be sunk from the upper side of the platform. A sketch of the apparatus is shown in fig. 4.

The boats are kept in their place by means of two or four anchors, as may be found necessary.

The form of the platform can be varied as it may be found convenient. One form is to be seen in the accompanying sketch, which is drawn from a photograph, showing the observations made on the Irtish River.

The measurements of velocity in one cross-section of the river should be performed at such intervals of time that the water level and generally the state of the river do not vary sensibly; consequently the work should be finished in one day—say, from 10 to 15 hours.

Now, as in a day of 10 to 15 hours it is difficult to make more than 15 to 18 complete measurements in a large river without the cable, and no more than 30 to 40 measurements with the cable; therefore, in the case of great rivers, 1,000 to 1,500 ft. wide, it is enough to make the measurements at intervals of 100 to 200 ft., and in small rivers at 50 to 100 ft.

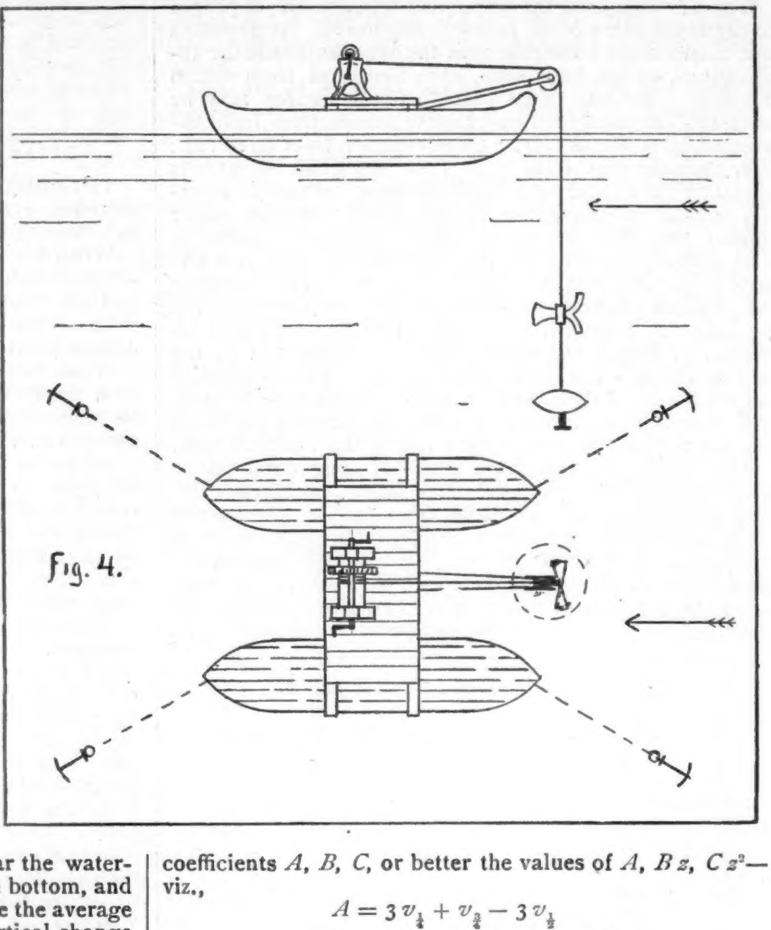


Fig. 4.

THE DETERMINATION OF AVERAGE VELOCITY IN A VERTICAL.

In order to get the approximate average velocity of water in a vertical, it is sufficient to measure the velocity at a point of that vertical, distant from the water-level 0.6, or exactly 0.577, of the total depth of water or total length of the vertical. Professor Beleloubski applied this method when determining the discharge of the Dnieper River for the design of the Ekaterinoslav bridge.

In order to get a more exact value of the average velocity in a vertical, the best method is the following: Measure the

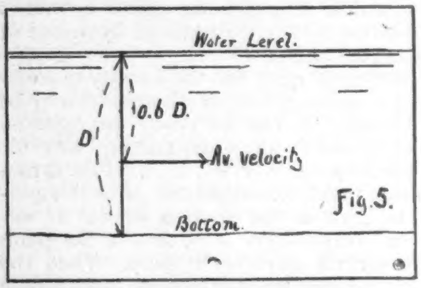


Fig. 5.

velocity at three points of the vertical; near the water-level, at the middle of the depth, and near the bottom, and from these three measured quantities calculate the average velocity, supposing that the velocities in a vertical change as the co-ordinates of the curve defined by the equation

$$v = A + B z + C z^2, \qquad (1)$$

in which the water-level is the axis of abscissæ and the vertical the axis of ordinates. The average velocity v_m will be equal to the area of the curve—*i.e.*, between the curve and axis of co-ordinates—divided by the total depth or length of the vertical.

Mr. Gnousin, a Russian civil engineer, who has performed many hydrographic and hydrometric surveys of rivers in Russia, in an article about the determination of velocities and discharges, advises for the sake of convenience that the three measured velocities be taken at the following depths expressed in fractions of the total depth.

Total Depth in Feet (z).	Three Depths from the Water-level in Fractions of Total Depth.		
	I.	II.	III.
2 to 4	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$
4 to 10	$\frac{1}{6}$	$\frac{1}{2}$	$\frac{5}{6}$
10 and more	$\frac{1}{10}$	$\frac{1}{2}$	$\frac{9}{10}$

We will develop the above formula (1) for each of these cases, and deduce the final formula for the average velocity.

In the first case, when the total depth $z = 2$ to 4 ft., the velocities are measured at depths equal to $\frac14$, $\frac12$, $\frac34$ of that depth—viz., $\frac14 z$, $\frac12 z$, $\frac34 z$—if that depth is 4 ft., the partial depths will be 1, 2, and 3 ft.—and the formula (1) being applied here gives

$$v_{\frac14} = A + \tfrac14 B z + \tfrac{1}{16} C z^2$$
$$v_{\frac12} = A + \tfrac12 B z + \tfrac14 C z^2$$
$$v_{\frac34} = A + \tfrac34 B z + {}^{9}\; C z^2.$$

Resolving these equations, we can get the values of the coefficients A, B, C, or better the values of A, $B z$, $C z^2$—viz.,

$$A = 3 v_{\frac14} + v_{\frac34} - 3 v_{\frac12}$$
$$B z = 2 (8 v_{\frac12} - 5 v_{\frac14} - 3 v_{\frac34})$$
$$C z^2 = 8 (v_{\frac34} - 2 v_{\frac12} + v_{\frac14}).$$

Therefore the average velocity will be

$$v_m = \frac{1}{z} \int_0^z (A + B z + C z^2)\, d z$$
$$= A + \tfrac12 B z + \tfrac13 C z^2,$$

or putting here the values of A, $B z$ and $C z^2$, finally

$$v_m = \frac{2 (v_{\frac14} + v_{\frac34}) - v_{\frac12}}{3}.$$

For the second case, when the total depth z is equal to 4 to 10 ft., and the velocities are measured at the partial depths $\frac16 z$, $\frac12 z$, and $\frac56 z$, by means of the same calculations as above, we get the formula

$$v_m = \frac{3 (v_{\frac16} + v_{\frac56}) + 2 v_{\frac12}}{8}.$$

For the third case, when the total depth z is more than 10 ft., and the partial depths are $\frac{1}{10} z$, $\frac12 z$, and $\frac{9}{10} z$, we get the formula

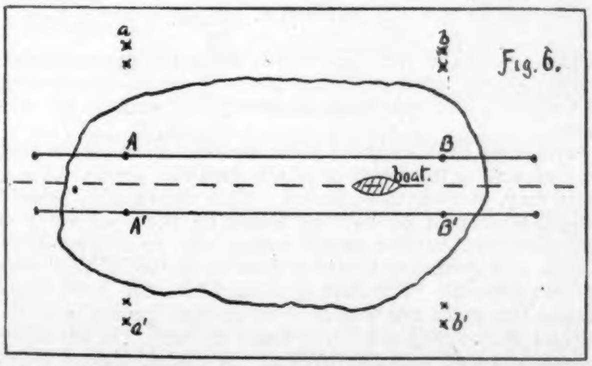
$$v_m = \frac{25\,(v_{\frac{1}{10}} + v_{\frac{9}{10}}) + 46\,v_{\frac{1}{2}}}{96}.$$

In order to verify the availability of the above supposition, it is advisable to measure in a few verticals the velocity at many points separated by small intervals, and from this immediate measurement calculate the average velocity.

The average velocity in a vertical can be also determined by the method of Treviranus, which consists in slowly sinking the hydrometric apparatus from the water-level to the bottom or inversely (allowing three seconds or more for each foot of depth), and calculating the velocity corresponding to the total number of revolutions divided by the depth.

THE MEASUREMENT OF VELOCITIES.

As above said, the most suitable apparatus for measuring the velocities of current at different depths are the hydrometric apparatus—*Moulinet, Flügel*—of Woltmann, or of Baumgarten, or of Amsler, the last with electric signal (bell) and winch for great depths.



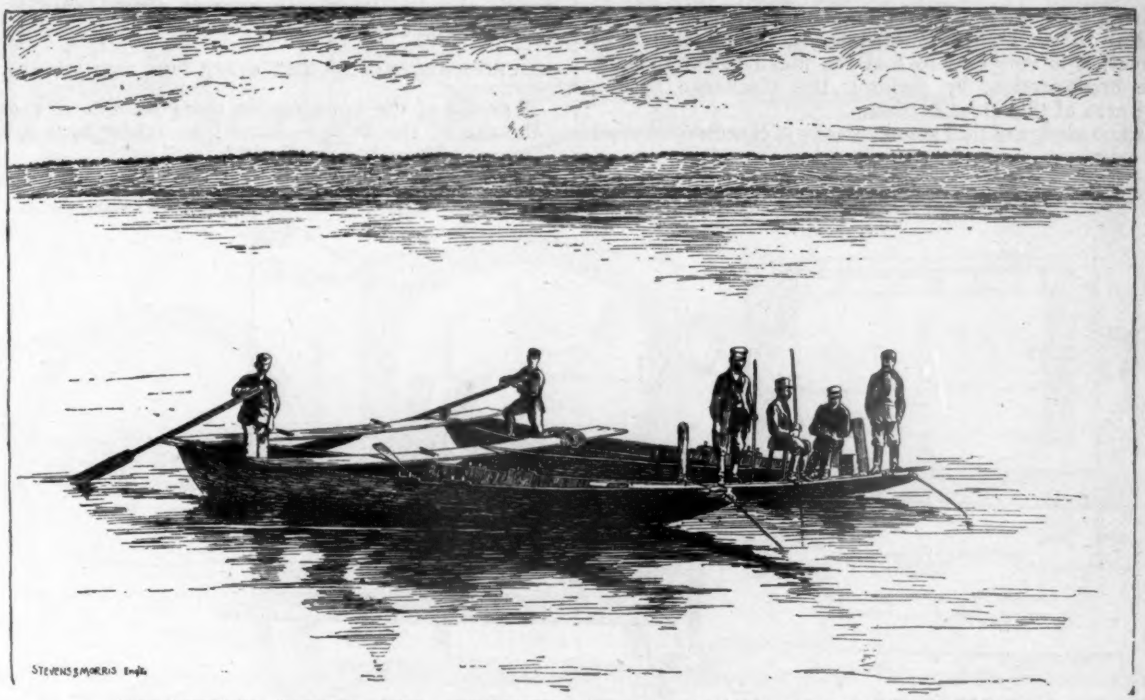
In the portions of the cross-section where the velocity is very small floats can be used.

Applying the above hydrometric apparatus, the velocity of current is calculated by the well-known formula

$$v = a + b\,n,$$

where n is the number of revolutions in a second, and a and b the constant coefficients to be determined from experiments in stagnant water.

For that purpose a pond or a small lake should be chosen; from one shore to the other two parallel leading ropes should be drawn, and between them a boat placed with the observer, as shown in fig. 6. The boat is to be put in motion by means of two ropes attached to the bow and to the stern. The hydrometric apparatus should be immersed from the front end of the boat, and as far as possible from it; the observer notes the time of motion and the number of revolutions (reading the quadrant without using the electric signal). The distance travelled over by the boat is measured by means of marks made on the leading ropes ($A\ A'\ B\ B'$) or by means of posts ($a\ a'$ and $b\ b'$) placed on the shores and giving two directions perpendicular to the line of motion of the boat. It is enough that the path of the boat be 100 to 150 ft.



MEASURING DEPTH AND VELOCITY OF THE IRTISH RIVER IN SIBERIA.

The velocity given to the boat by means of a rope and men, moving in a direction perpendicular to the shore, can be varied from ½ ft. to 4 ft. in a second; however, it would be desirable to reach a still greater velocity, say, 5 to 6 ft. In order to calculate duly and with sufficient accuracy the coefficients a and b, it is necessary to make from 25 to 50 observations with different speeds of the boat.

If we designate by s the path traveled by the boat, by t the time required, and by N the total number of revolutions, then the fractions $\frac{s}{t}$ and $\frac{N}{t}$ will give us the velocity of motion v, and the number of revolutions in a second—viz.,

$$\frac{s}{t} = v, \qquad \frac{N}{t} = n,$$

and from the series of these quantities, by means of the method of least squares, the coefficients a and b will be calculated by the formulæ

$$b = \frac{m\,\Sigma\,n\,v - \Sigma\,n\,\Sigma\,v}{m\,\Sigma\,n^2 - (\Sigma\,n)^2}$$

$$a = \frac{\Sigma\,v - b\,\Sigma\,n}{m},$$

where m is the number of observations made in stagnant water and Σ the ordinary sign of summing up.

In calculating these coefficients in feet, it is quite sufficient to calculate the coefficient a with one or two decimals, and the coefficient b with two or three decimals.

The observations of the velocity of the current, made by

means of the hydrometric apparatus with electric signal, consist in noting the time corresponding to every 100 revolutions, marked by the sounding of the electric bell. Each of such observations should last from two to three minutes, in order to include the period of fluctuations of the velocity of the current, which in great rivers is generally equal to that interval of time—two to three minutes.

THE MEAN VELOCITY OF A CROSS-SECTION CORRESPONDING TO THE HIGHEST WATER-LEVEL.

Having thus determined the maximum discharge, corresponding to the highest water-level in a cross-section of the river, it is very easy to find the mean velocity of the whole cross-section, by dividing this discharge by the whole area of this cross-section.

The knowledge of that mean velocity is especially needed for the reason that, according to Weissbach, it is approximately equal to the maximum velocity on the bottom, the knowledge of which is necessary for stating the conditions of the washing out or sweeping of the river-bed.

TOPOGRAPHIC PLAN OF THE PART OF THE RIVER AND ITS INUNDATION OR FLOOD LIMITS.

At least a mile above and a mile below the point of the river crossing, and in addition at the normal portion of river chosen for the determining of discharge, the limits of floods should be accurately topographically leveled on a scale of $\frac{1}{5,000}$ or $\frac{1}{10,000}$. The plan should show the river shores at the lowest level of water, the limits of inundation; in the plan of the river channel the lines of equal depths and the direction of the current, and in the limits of inundations the horizontal lines and the direction of the general current and of particular currents, in secondary channels if there are any, during the highest flood.

The surveying can be performed by means of the surveyor's table or theodolite, and when the width of the river is very great, the shores may be connected by means of triangulation, which should be the base for the surveying of the shores.

The mode of determining the direction of the currents was described in the chapter on the selection of cross-sections.

Having such an accurate plan of the river, it is now possible to define exactly the site of the crossing—viz., the axis of the designed bridge, according to the above-mentioned rules as follows:

1. The axis of the bridge should be as nearly as possible perpendicular to the direction of the high-water current.

2. The direction of the high-water current should, if possible, coincide with the low-water current; and when this condition cannot be satisfied, the center of the clear span should coincide with the chief current of the high-water, and the low-water current should pass in the middle of one of the spans.

CROSS-SECTION OF THE RIVER-BED AND SHORES.

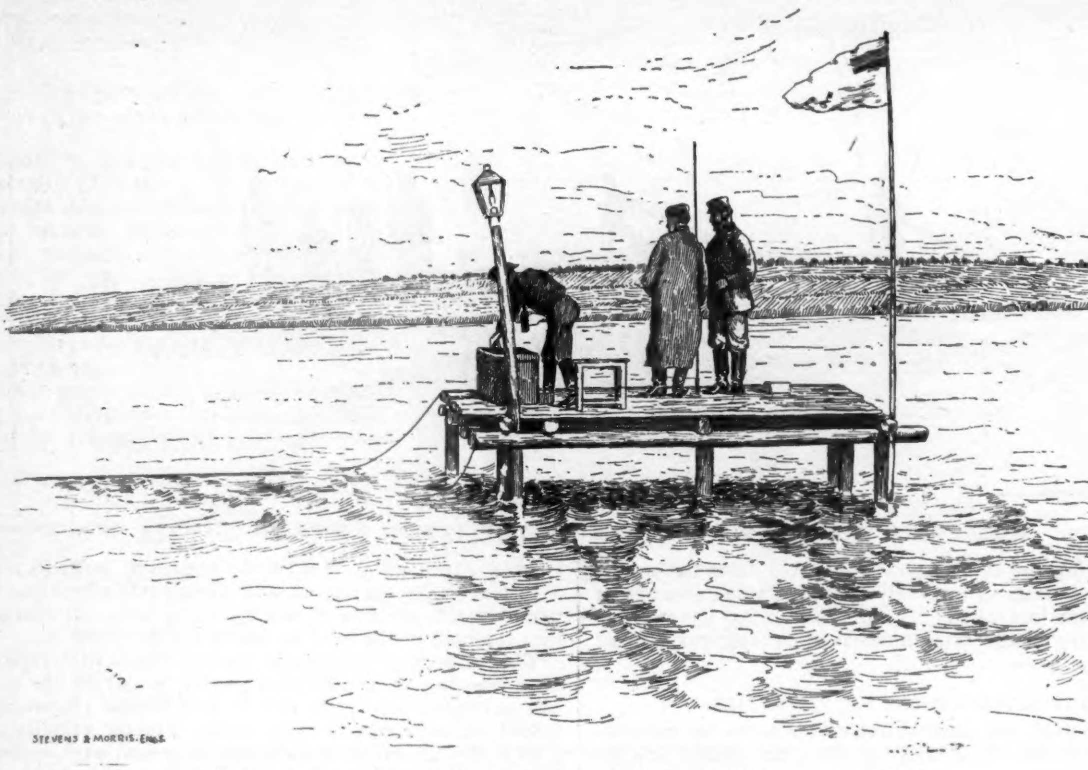
A profile of the cross-section along the line of crossing —the axis of the bridge—should be taken by means of soundings of the river-bed and leveling the shores. This profile should contain all the levels of water—the lowest, the highest, and the levels of spring and autumn ice running.

The same profile should show the kind of soil of the bed, and especially the depth at which the solid ground—rock, solid clay, etc.—is to be found. This information should be got by means of borings made on the shores and in the river-bed to the depth where the solid ground is found, and generally no more than 75 or 100 ft. below the low-water level. The borings should be made in the spots where the piers are expected to be, and generally at intervals of 300 to 500 ft. For these borings it is advisable to use a small portable drilling apparatus, making holes from 1⅜ in. to 2½ in. in diameter. Most excellent apparatus of this kind are made by Woïslav in St. Petersburg, and by the F. C. Austin Manufacturing Company in Chicago.

The illustration given is from a photograph of a party engaged in making borings in the bed of the Irtish River in Siberia at the point chosen for the crossing of the Siberian Railroad.

Analogous profiles should be made of the normal portions of the river selected for the determination of discharge; but it will not be necessary to make borings at those points.

(TO BE CONTINUED.)



BORING IN THE BED OF THE IRTISH RIVER IN SIBERIA.

BUILDING AN UNDERGROUND RAILROAD.

THE Glasgow Central Railroad is a city line, chiefly underground, which is now under construction through the city of Glasgow, in Scotland, from the Dalmarnock Viaduct, on the Caledonian Railroad, to a double terminus at Maryhill and Dawsholm, on the opposite side of the city. The total length is $6\frac{1}{4}$ miles, of which about $5\frac{3}{4}$ miles are in tunnel, the rest in open cutting.

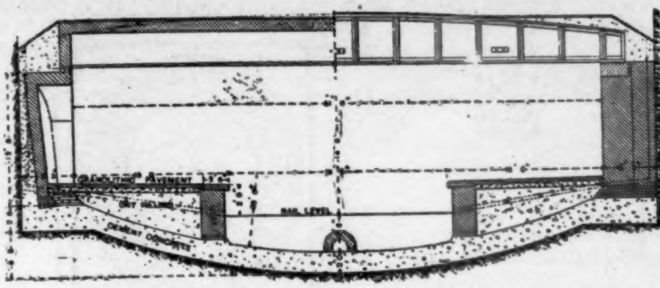


Fig. 3.—Transverse Section of Covered Way for Central Station, Trongate Section

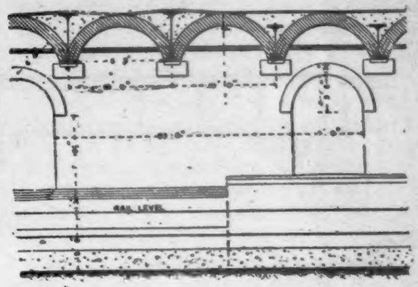


Fig. 4.—Longitudinal Section of Covered Way for Central Station.

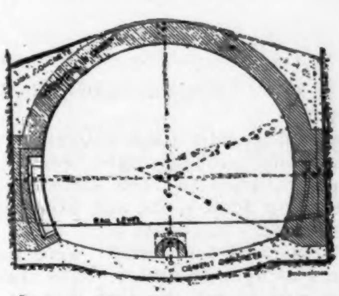


Fig. 5.—Transverse Section of Covered Way No 1

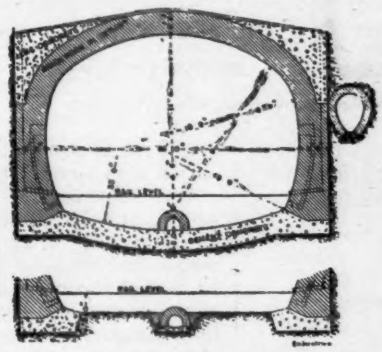


Fig. 6.—Transverse Section of Covered Ways Nos. 1 and 9, with and without Invert.

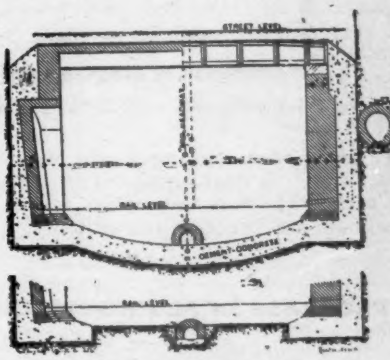


Fig. 7.—Transverse Section of Covered Way No. 3, with and without Invert.

THE GLASGOW CENTRAL RAILWAY TUNNEL, GLASGOW, SCOTLAND.

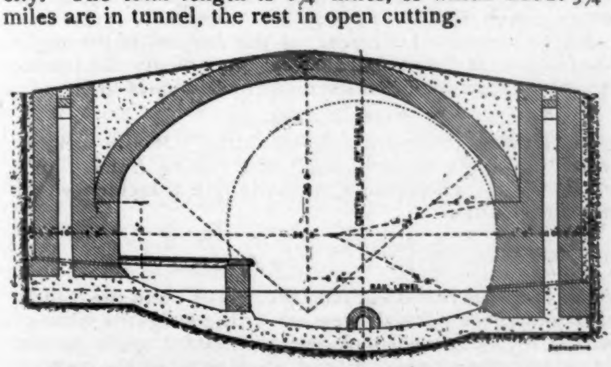


Fig. 2.—Transverse Section of Covered Way No. 7, Bridgeton Section.

The sections adopted for the tunnel vary considerably, according to the depth below the surface. At some points an ordinary cylindrical arch is used; at others a flatter arch, and at others again the line is so near the surface that the street is supported by girders. The accompanying drawings, for which we are indebted to *Industries*, show sections of the tunnel at different points. Figs. 2, 3 and 8 are taken at points where there are stations, and the tunnel is widened out to take in the platforms.

The method adopted for working under the streets of the city where the tunnel passes seems to be a very good one. Rows of piles are first driven on either side by an overhead traveler, spanning the entire roadway and permitting vehicular traffic to pass beneath it. The platform of the traveler carries pile drivers, boilers, etc., and piling is performed on either side. The legs of the traveler are carried on rails, and when one length of the street is finished the traveler is moved on. The next operation consists in taking up the roadway and substituting timbering to carry the traffic; such timbering being supported by the piles already driven. Tunneling then proceeds beneath the timbered street, and were it not for the manholes here and there, through which soil is being brought up or material lowered down, few persons would be aware of the work carried on only some few inches beneath their feet. The ordinary operations of tunneling are carried out as follows: In advance a gang of men are excavating by hand, the side walls are built up to follow, and the arching on timber centring completes the work. The timbering forming the street is then removed, and the vacant spaces made up to street level. In this manner length by length of the work is rapidly proceeding without any hindrance whatever to the ordinary vehicular traffic.

As in all city structures of this kind, the greatest difficulties are found in crossing the sewers which are intersected by the tunnel. Some of these are of large size, and are important factors in the drainage of the city. The general plan adopted has been to carry the sewers under the tunnel, providing ample accommodation for an increase in size should it be required hereafter. At several points also careful work was needed to avoid injury to the foundations of buildings.

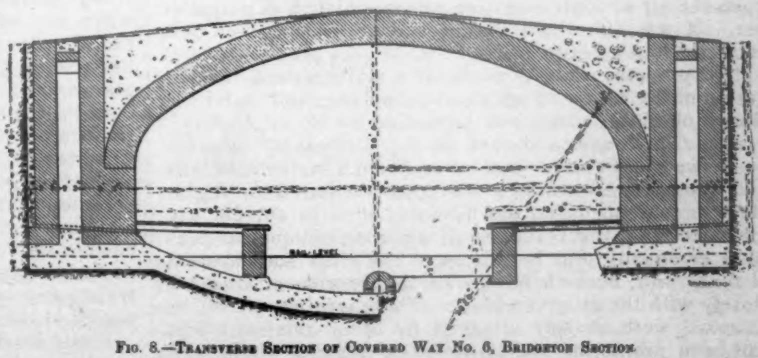
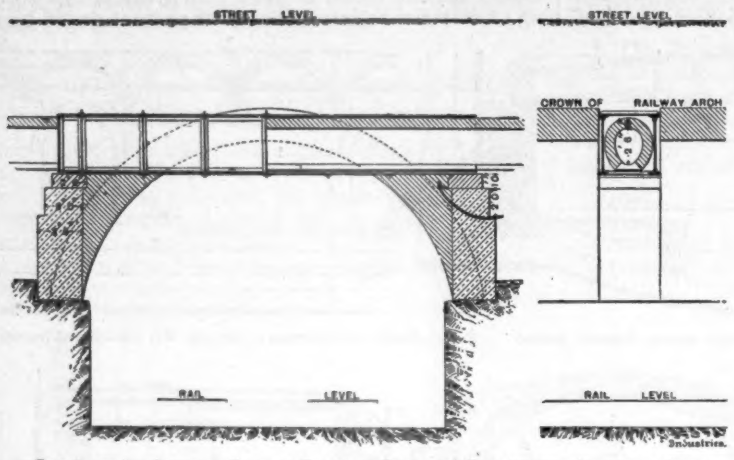


Fig. 8.—Transverse Section of Covered Way No. 6, Bridgeton Section.

Some other difficulties were met with, chiefly owing to the fact that portions of the tunnel are built through fine sand, and are below the water level in this sand, so that much care was required in excavating and lining. But little rock-work has been required.

Figs. 9, 10 and 11 show one method of carrying a sewer over the tunnel, which was adopted at one street crossing. This consisted, as will be seen from the drawings, in the use of steel-plate girders resting on an abutment at each side, the girders coming a little below the crown of the tunnel arch. A floor supported by these girders carries the sewer, which is thus taken across the top of the tunnel without any break in its continuity.



FIGS. 9 AND 10.—SECTIONAL VIEWS OF TUNNEL AT DUMBARTON ROAD, SHOWING CROSSING OF SEWER.

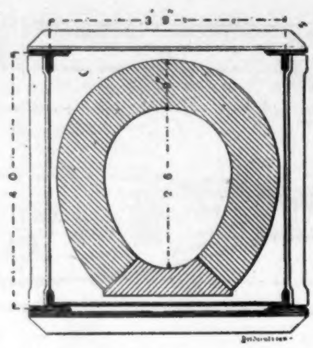


FIG. 11.—TRANSVERSE SECTION OF STEELWORK CARRYING SEWER UNDER DUMBARTON ROAD

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 372.)

IN 1863 M. *de Louvrié*, a French engineer and mathematician, proposed the apparatus shown in fig. 43, which he called an "aeroscaphe." It consisted in a kite-like surface, stiffened by light cords to a mast above and to the car below, and capable of acting as a parachute, as well as of being folded like the wings of a bird. It was intended to progress through the air either through the agency of a screw driven by a motor, or more directly by the reaction upon the air of some explosive substance, such as gunpowder. It was submitted to the French Academy of Sciences, but no experiments were made on a practical scale.

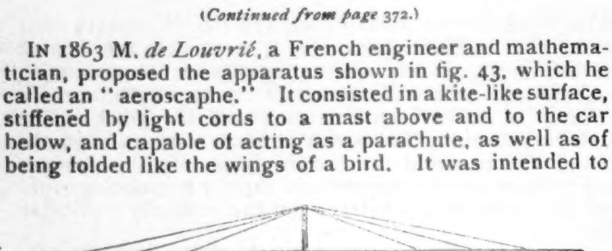


FIG. 43.—DE LOUVRIÉ—1863.

This proposal was the result of a mathematical investigation of the action of air upon aeroplanes and under the wings of birds, which was published by M. *de Louvrié*, first in *Les Mondes* and then in the *Aéronaute*,* wherein he showed that *Navier* and other French mathematicians had grossly overestimated the power required for flight. He also contended that the formulas then in current use for calculating the reactions of air upon oblique surfaces were erroneous, and he advanced the empirical formula of *Duchemin*, hereinbefore given, as agreeing much more closely with the observed facts. These writings of M. *de Louvrié* were sharply attacked by other aviators,† who had been promoting the imitation of flapping wings, and who denied altogether the possibility of soaring or sailing flight of birds, so that a lively controversy ensued, which has continued to this day, for M. *de Louvrié* published in 1890* a new formula on a rational basis, of fluid action upon oblique surfaces, which agrees very closely in its results with those of the *Duchemin* formula, and he has also written an article on the "Theory of Sailing Flight," which is to appear shortly.

The "aeroscaphe" was practically a kite without string or tail, and its stability would probably have been found deficient, but M. *de Louvrié* tried in 1866 some experiments with a model weighing some 9 lbs. and exposing a surface of about 11 sq. ft. This ran upon a car on an inclined plane, and the "lift" and the "drift" were carefully measured by means of dynamometers. The results of these experiments demonstrated the fact that at all velocities and for all angles the "drift" or resistance of a plane to motion is to the "lift" or supporting pressure as the *sine* of the angle of incidence to its *cosine*; as indeed was to be expected from theoretical considerations, and as had been laid down in 1809 by Sir George Cayley, in the article which has already been herein quoted.

As the *sine* is to the *cosine*, as the *tangent* of the angle M. *de Louvrié* deduced from his experiments the fundamental formula for the resistance of aeroplanes to be

$$R = W \text{ tang. } @,$$

in which R is the resistance or "drift," W the weight, and @ the angle of incidence; and calling L the "lift" and P' the normal pressure, at that angle of incidence, we may write further:

$$\begin{aligned} R &= W \text{ tang. } @ = P' \text{ sin. } a \\ L &= W \qquad\quad\;\; = P' \text{ cos. } a, \end{aligned}$$

which formulas furnish at once the "drift" and the "lift" when either the normal pressure or the weight is known. In 1868 M. *de Louvrié* took out a second French patent for an aeroplane, in which he chiefly described the method of stretching the kite sail by adjustable radiating arms. It was to have a flat diedral angle to provide stability sideways, and was to be driven by a hot air engine, but no experiments seem to have been made. Since then he is understood to have abandoned the promotion of aeroplanes, and to expect more favorable results from his "anthropornis," which has already been noticed under the head of "wings and parachutes."

It may be incidentally here mentioned that a somewhat similar proposal for a circular kite or flat parachute was patented in the United States by Mr. *Wooton* in 1866. It must have been found, if experimented with, quite deficient in stable equilibrium; any square, round, or polygonal surface being quite inferior in stability to the comparatively long and narrow wings which form the sustaining aeroplanes of the birds.

While it seems certain, from the shape and arrangement of the apparatus of *Carlingford*, *Du Temple* and *De Louvrié*, that they had in mind the possibility of soaring upon the wind like a bird, they all proposed some kind of an artificial motor, and none of them was bold enough,

* *L'Aéronaute*, September, October and November, 1868.
† *Ibid.*, December, 1868; January and February, 1869.

* *Revue de l'Aéronautique*, Vol. 3, page 102.

in the face of existing prejudice, to propose to trust to the wind alone as a motive power. This was reserved for Count *D'Esterno*, who published in 1864 a very remarkable pamphlet* upon the evolutions and flight of birds, in which he gave the results of his many years of close observation, and formulated what he considered to be "the seven laws of flapping flight and the eight laws of soaring flight." He held that the act of flight involved the providing for three distinct and indispensable requirements—*i.e., equilibrium, guidance* and *impulsion*, and that the latter could be obtained from the wind whenever it blew strongly enough. He says in his pamphlet:

"Sailing flight labors under the disadvantage that it cannot take place without wind; but, on the other hand, we can derive from the wind, when it blows, an unlimited power, and thus dispense with any artificial motor. In sailing (or soaring) flight, a man can handle an apparatus to carry 10 tons, just as well as one only carrying his own weight. Whoever has seen large birds of prey sailing upon the wind, knows that without one flap of their wings they direct themselves as they choose, save when they want to go dead with the wind or dead against it, on which occasions they must either tack or sweep in circles."

He patented in 1864 the apparatus shown in fig. 44, consisting of two wings hinged to a frame at the side of a central car, so that they could be set at any diedral angle, or even

FIG. 44.—D'ESTERNO—1864.

flapped should a motor be applied. The front end of the frame was provided with trunnions fitting in sockets inserted in the car, so that the rear end of the wings could be raised or lowered, thus altering the angle of incidence, and incidentally moving the wings forward or backward with respect to the car. The wings themselves were to be rigid within the triangles next to the car, and made flexible in the rearward portion, where the curved ribs are shown, which latter might be made of whalebone. It was claimed that these wings would thus be capable of three movements, corresponding to the first three "laws" laid down by *D'Esterno*: 1. An up-and-down or flapping action; 2. A forward or backward inclination, and 3. A torsional or twisting motion. The tail was connected with the car with a universal joint, and had also three motions corresponding to the next three laws—viz.: 4. An up-and-down oscillation; 5. A lateral displacement sideways, and 6. Torsion. The car was provided with a movable seat, and the operator could either sit thereon, and shift his weight forward and back or sideways, or he might stand up and effect the same object by swaying his body or moving about, this action displacing the center of gravity of the apparatus, and corresponding to the seventh law of flapping flight, or means for the maintenance of equilibrium; to which for sailing flight *D'Esterno* added still an eighth requirement or "law" in affirming the necessity for an initial headway.

He indicates in his book that an apparatus for one man would weigh, with the operator, approximately 330 lbs., and spread an equal number of square feet of horizontal surface, 215 sq. ft. of which would be in the two wings, each being approximately 15½ ft. long by 7 ft. wide, and he describes in his patent, mechanism somewhat crude, chiefly consisting of ropes and drums, for producing the various motions described.

The proposed mode of actual operation is not described, but it must have been nearly identical with the evolutions of the sparrow-hawk in the excursion which has been described. The apparatus would first descend in order to obtain an initial velocity, after which, having a speed of its own, it might utilize that of the wind. During this descent the fore-and-aft plane of the wings would have to point below the horizon, and if the reader will refer to the various attitudes of the sparrow-hawk on fig. 36, he will note that between points *A* and *B* his wings were scarcely open, in order to diminish the "drift." Once the speed gained, the apparatus would needs alter its center of gravity in order to change upward the angle of incidence and to come on a nearly level keel. If it went dead with the wind, its relative speed would have to be great enough to furnish support; if going dead against the wind, it would lose headway but gain elevation; and it might tack on a quartering wind or describe a series of helical orbits, like those of the birds. If the latter were chosen, the apparatus would, when it had the wind in its quarter, be sailing into the "eye of the wind" and faster than it blew, just as in the case of the ice boat; while it would probably need to descend a little on the part of the circle when it was going with the wind, and would be enabled to rise materially when, upon facing the wind, the force of the latter was added to its own initial velocity. Thus, at every turn height would be gained, this being acquired when going against the wind; and height once obtained, the apparatus would be able to sail in any direction by descending.

It will be noted, however, how many delicate manœuvres are requisite to accomplish these evolutions: to alter the angle of incidence, the direction, the speed, and to maintain the equilibrium at all times. The bird does all this by instinct; he performs the exact manœuver required accurately, at exactly the right time, and he is always master of his apparatus; but the man would be at a terrible disadvantage, his perceptions and his operations would be too slow, and a single false movement might be fatal.

There probably would have been many mishaps at first with Count *D'Esterno's* apparatus had it been experimented, and being aware of this difficulty, he proposed that the experiments should be conducted over water sufficiently deep to break the fall, the apparatus being raised, like a kite, by a cord fastened ashore, which the operator could hold fast or abandon at will, while he was acquiring the science of the birds.

At that time (1864) aviation was not in public favor, and the very existence of soaring or sailing flight of birds was strenuously denied. It was held that there must be some small movements of the wings, which sustained the bird in the air, and which the observers had failed to detect, and it was not till the subsequent observations of *Pénaud, Wenham, Basté, Peal, Darwin, Mouillard*, and others that it was admitted that a bird might sail by the sole force of the wind without flapping.

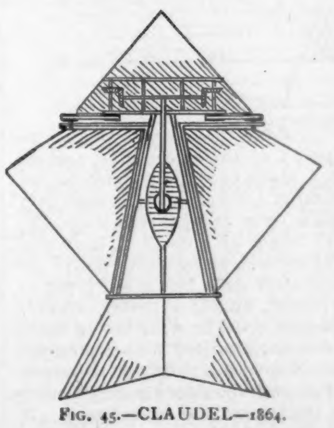


FIG. 45.—CLAUDEL—1864.

Count *D'Esterno's* proposal was generally laughed at as an evidence of mild lunacy, and whether because of this reason or because he distrusted the efficacy of his own mechanism, he did not build his apparatus. This is the more to be regretted because, being in possession of an ample fortune, he might have tried a number of valuable experiments which, if they did not result in success (as they probably would not), might yet have greatly advanced the fund of knowledge upon this intricate subject. Later on, when aviation grew in favor, and he was urged by members of the French Aeronautical Society, he conferred with various ingenious mechanics, and in 1883 he made an arrangement with M. *Jobert* to build a soaring apparatus. This was well under way when, in that same year, Count *D'Esterno* died at the age of 77. The apparatus was never com-

* "Du Vol des Oiseaux," D'Esterno, 1864.

pleted, and, such as it is, has been deposited in the Exposition Aéronautique.

A singular proposal was that of M. *Claudel,* who patented in 1864 the apparatus shown in fig. 45. This consisted of two aeroplanes, one at the front and one back, propelled by two wings, lozenge-shaped, and rotated upon pivots at each apex. If they were made flexible the resistance of the air would bend these wings into an elongated screw, and some propelling effect might be produced. They were to be driven by bevel gears set in motion by a steam engine in the car; but it is not known whether any practical experiments were ever tried.

In 1866 Mr. *F. H. Wenham* patented the meritorious proposal of superposing planes or surfaces above each other, so as to increase the supporting area without increasing the leverage. These were to be "kept in parallel planes by means of cords, or rods, or webs of woven fabric. . . . The long edges of the surface," made of silk or other light material, to be placed "foremost in the direction of motion." This system of surfaces being arranged above a "suitable structure for containing the motive power." If manual power was employed, the body of the operator was to be placed in a *horizontal* direction, and "the arms or legs to work a slide or treadle from which the connecting cords convey a reciprocating motion to oars or propellers, which are hinged above the back of the person working them."

In a very able paper, which has become classical, read at the first meeting of the Aeronautical Society of Great Britain, in 1866, Mr. *Wenham* gave an account of his observations, concluding with a very valuable discussion of the problem of flight, and with the following description of his experiments:

Having remarked how thin a stratum of air is displaced beneath the wings of a bird in rapid flight, it follows that in order to obtain the necessary *length* of plane for supporting heavy weights, the surfaces may be superposed or placed in parallel rows, with an interval between them. A dozen pelicans may fly, one above the other, without mutual impediment, as if framed together; and it is thus shown how two hundred weight may be supported in a transverse distance of only 10 ft.

In order to test this idea, six bands of stiff paper 3 ft. long and 3 in. wide were stretched at a slight upward angle in a light rectangular frame, with an interval of 3 in. between them, the arrangement resembling an open Venetian blind. When this was held against a breeze, the lifting power was very great; and even by running with it in a calm it required much force to keep it down. The success of this model led to the construction of one of a sufficient size to carry the weight of a man. Fig. 46 represents the arrangement, being an end eleva-

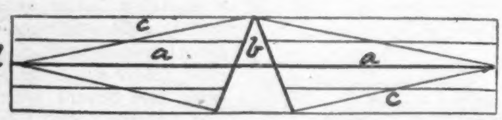


FIG. 46.—WENHAM—1866.

tion; *a a* is a thin plank tapered at the outer ends, and attached at the base to a triangle, *b*, made of similar plank for the insertion of the body. The boards *a a* were trussed with thin bands of iron *c c*, and at the ends were vertical rods *d d*. Between these were stretched five bands of holland 15 in. broad and 16 ft. long, the total length of the web being 80 ft. (100 sq. ft. of surface). This was taken out after dark into a wet piece of meadowland one November evening, during a strong breeze, wherein it became quite unmanageable. The wind acting upon the already tightly stretched webs, their united pull caused the central boards to bend considerably, with a twisting, vibratory motion. During a lull, the head and shoulders were inserted in the triangle, with the chest resting on the base board. A sudden gust caught up the experimenter, who was carried some distance from the ground, and the affair, falling over sideways, broke up the right-hand set of webs.

In all new machines we gain experience by repeated failures, which frequently form the stepping-stones to ultimate success. The rude contrivance just described (which was but the work of a few hours) had taught, first, that the webs or aeroplanes must not be distended in a frame, as this must of necessity be strong and heavy to withstand their combined tension; second, that the planes must be made so as either to furl or fold up for the sake of portability.

In order to meet these conditions, the following arrangement was afterward tried: *a a*, fig. 47, is the main spar, 16 ft. long, ½ in. thick at the base, and tapered, both in breadth and thickness, to the end; to this spar was fastened the panels *b b*, having a base board for the support of the body. Under this, and fastened to the end of the main spar, is a thin steel tie band, *e e*, with struts starting from the spar. This served as the foundation of the superposed aeroplanes, and, though very

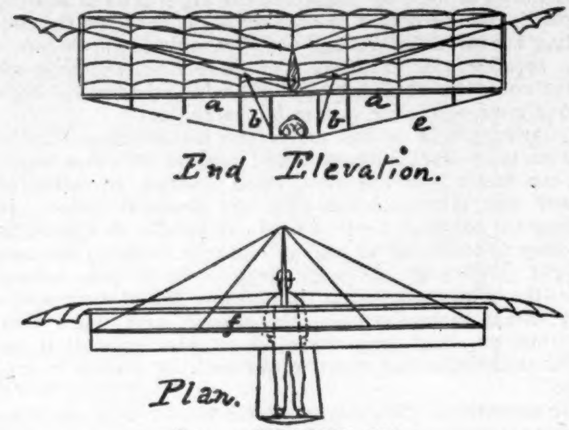


FIG. 47.—WENHAM—1866.

light, was found to be exceedingly strong; for when the ends of the spar were placed upon supports, the middle bore the weight of the body without any strain or deflection; and further, by a separation at the base-board, the spars could be folded back with a hinge to half their length. Above this were arranged the aeroplanes, consisting of six webs of thin holland 15 in. broad (giving 120 sq. ft. of supporting surface); these were kept in parallel planes by vertical divisions 2 ft. wide of the same fabric, so that when distended by a current of air, each two feet of web pulled in opposition to its neighbor; and finally, at the ends (which were sewn over laths), a pull due to only 2 ft. had to be counteracted, instead of the strain arising from the entire length, as in the former experiment. The end pull was sustained by vertical rods, sliding through loops on the transverse ones at the ends of the webs, the whole of which could fall flat on the spar till raised and distended by a breeze. The top was stretched by a lath, *f*, and the system kept vertical by stay-cords taken from a bowsprit carried out in front. All the front edges of the aeroplanes were stiffened by bands of crinoline steel. This series was for the supporting arrangement, being equivalent to a length of wing of 96 ft. Exterior to this two propellers were to be attached, turning on spindles just above the back. They are kept drawn up by a light spring, and pulled down by cords or chains running over pulleys in the panels *b b*, and fastened to the end of a swiveling cross-yoke sliding on the base-board. By working this cross-piece with the feet, motion will be communicated to the propellers, and by giving a longer stroke with one foot than the other, a greater extent of motion will be given to the corresponding propeller, thus enabling the machine to turn, just as oars are worked in a rowing boat. The propellers act on the same principle as the winds of a bird or bat; their ends being made of fabric stretched by elastic ribs, a simple waving motion up and down will give a strong forward impulse. In order to start, the legs are lowered beneath the base-board, and the experimenter must run against the wind.

An experiment recently made with this apparatus developed a cause of failure. The angle required for producing the requisite supporting power was found to be so small that the crinoline steel would not keep the front edges in tension. Some of them were borne downward, and more on one side than the other, by the operation of the wind, and this also produced a strong fluttering motion in the webs, destroying the integrity of their plane surfaces, and fatal to their proper action.

Another arrangement has since been constructed having laths sewn in both edges of the webs, which are kept permanently distended by cross stretchers. All these planes are hinged to a vertical central board, so as to fold back when the bottom ties are released, but the system is much heavier than the former one, and no experiments of any consequence have yet been tried with it.

It may be remarked that although a principle is here defined, yet considerable difficulty is experienced in carrying the theory into practice. When the wind approaches to 15 or 20 miles per hour, the lifting power of these arrangements is all that is requisite, and, by additional planes, can be increased to any extent; but the capricious nature of the ground-currents is a perpetual source of trouble.

If Mr. *Wenham* tried any further experiments with his apparatus, he has not, to the writer's knowledge, published an account of the results. They would be nearly certain to be unsatisfactory for want of stable equilibrium. The *Wenham* aeroplane was even more unstable than that of the bird, and the latter is constantly in need of adjustment, to counteract the "ground currents" and the variations in speed and in the angle of incidence. Moreover, the *horizontal* position selected by Mr. *Wenham* was most unfavorable because unnatural to man, in directing the movements of an apparatus; so that as often as he might rise upon the wind, just so often he was sure to lose his balance and to come down with more or less violence. The two propellers described by him would of course have proved quite ineffective in sustaining the weight, because man's muscular power is quite insufficient to have worked them with a speed adequate to that purpose, but they might have served to direct the course, had the equilibrium of the apparatus been stable.

Indeed, the writer believes that the first care of the aviator who seeks to solve the problem of flight, must be to seek for some form of apparatus which shall be, if possible, more stable in equilibrium than the bird. The latter is instinct with life; he meets an emergency instantly. Man's apparatus will be inanimate, and should possess automatic stability. Safety is the first requisite—safety in starting, in sailing, and in alighting, and the latter operation must be feasible almost everywhere without special preparation or appliances before the problem can be said to be fairly solved. It will probably prove the most difficult detail to accomplish, but it does not seem impossible when we see the feat performed by the birds so many times every day.

Mr. *Wenham's* proposal to superpose planes to each other in order to obtain large supporting surfaces without increasing the leverage, and consequent weight of frame, will probably be found hereafter to be of great value. The French experimenter *Thibaut* found that when two equal surfaces were placed *one behind the other*, in the direction of fluid motion, the resistance more nearly equaled that of the two separate surfaces than might be supposed. Thus for two square planes, placed at a distance apart equal to their parallel sides, so as to cover each other exactly, M. *Thibaut* found the resistance equal to 1.7 times that of one single surface. When the hinder plane projected by 0.4 of its surface beyond the front plane, the resistance was 1.95 times that of the single surface. This diminished to 1.84 times, when it became 0.9. Beyond this it reached nearly twice the resistance.*

Professor *Langley* found in his experiments with superposed planes, 15 × 4 in., soaring at horizontal speed, that "when the double pairs of planes are placed 4 in. apart or more, they do not interfere with each other, and the sustaining power is, therefore, sensibly double that of the single pair of planes; but when placed 2 in. apart, there is a very perceptible diminution of sustaining power shown in the higher velocity required for support and in the greater rapidity of fall." †

We may hence conclude that there will result a material, indeed a great advantage in superposing planes, provided they are so spaced as not materially to interfere with each other, and provided also that they are arranged so as to afford a good equilibrium.

(TO BE CONTINUED.)

ELECTRIC SAFETY SIGNALS.

THE London *Times* comments as follows on the electric signal devices shown at the Electric Exhibition now in progress in London:

Unquestionably the exhibits of the trial appliances for the better securing of safety to railroad trains are of leading importance, and, as a whole, merit something more than a mere passing record. They illustrate one of the most anxious and difficult problems railroad officials have to deal with, and they afford evidence of the great amount of skill and ingenuity that have been expended on the subject. It is, however, a matter for grave reflection that, in spite of all the precautions taken and of the perfection attained in this connection, it is, after all, open to human fallibility to step in and pave the way to accident, as we shall show. Technically the contrivances exhibited are known as effecting electrical interlocking, to be used in addition to what may be described as the ordinary mechanical system of interlocking points and signals. The combination has been—not inaptly—designated as a union of the lock and block systems. Both of these systems separately are required by Act of Parliament to be provided on all the railroads of the United Kingdom, but up to the present time it is not a Board of Trade requisition that they shall be used in combination. Nevertheless, such combined action and interdependent working of the lock and block systems is recognized by practical railroad men as adding greatly to the safe working of railroads, and it is now being adopted on some of the leading lines. The absolute block system is of itself most excellent, and but for the element of human fallibility in working, it would be almost absolutely reliable. That element, however, has to be dealt with. For instance, signal-man A telegraphs to signal-man B that the line is blocked. B misinterprets or disregards the message, and inadvertently lowers the out-door signal and permits a train to pass into a section of the line which is blocked or not cleared by a previous train, and an accident, or a great risk of one, is the result. To obviate this danger an electric lock is applied to the hand levers of the out-door signals, so that either signal-man A or B, when he receives a telegraphic indication that the line is blocked, is prevented from moving his hand lever to give a signal which would be contrary to such indication. In one of the modern safety appliances exhibited, the electric lock acts upon the out-door signal itself instead of upon the hand lever in the signal-man's cabin; and this is doubtless, in certain respects, an improvement. But there is a step in advance of this in another appliance, which appears to afford the greatest security against human fallibility. This is the treadle arrangement, which is placed on the line, and which gives automatic control of the out-door signal to the train itself. This, however, does not in any way interfere with or lessen the responsibility of the signal-man. It is only supplementary; but if either or both the signal-men simultaneously should make a mistake by omitting to put a signal to danger, or by attempting prematurely to exhibit a safety signal, the train itself so acts upon the signal through the treadle arrangement that any irregular act of the signal-man, either of omission or commission, is counteracted and rendered harmless.

ELECTRICITY ON RAILROADS.

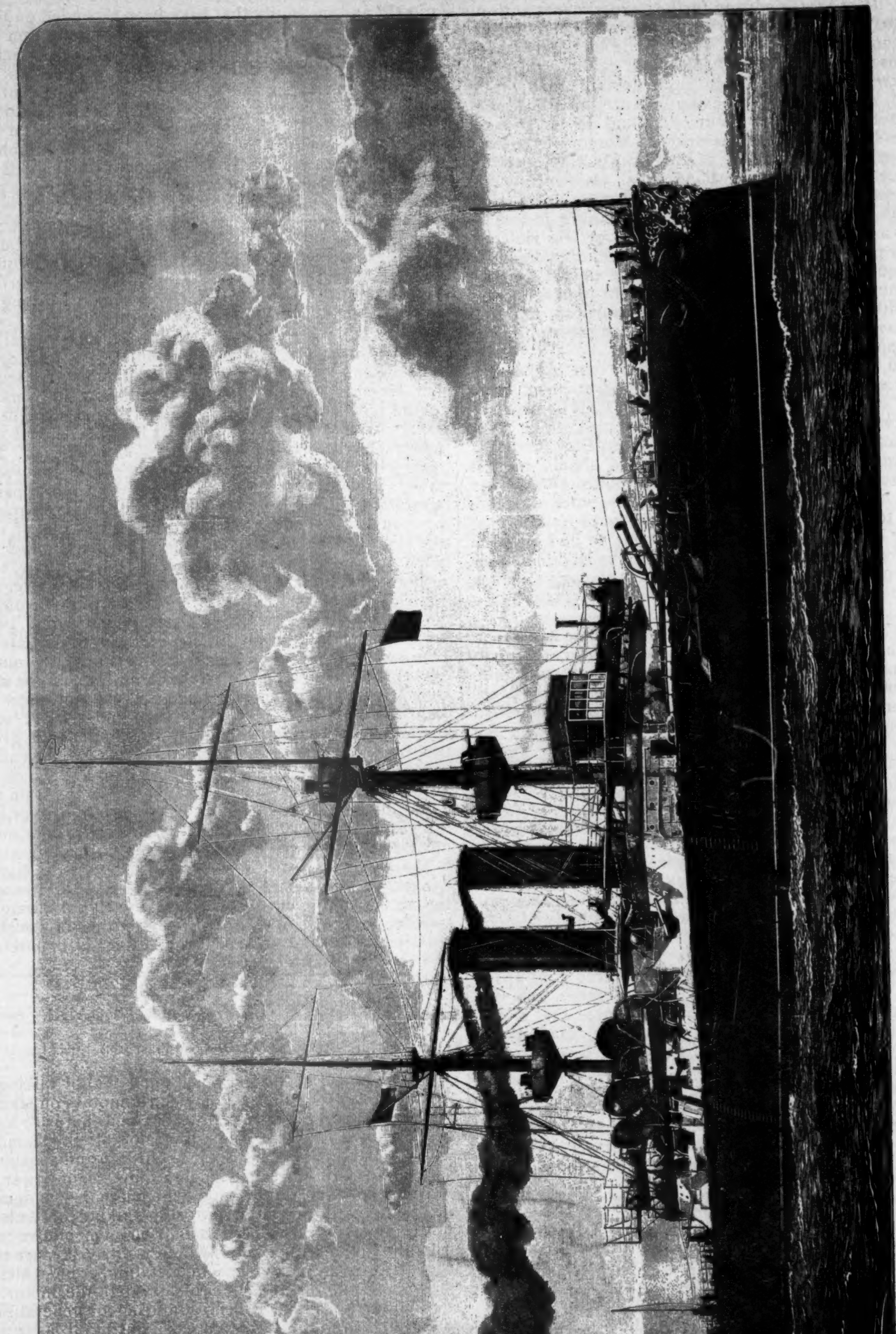
(From *Industry*, San Francisco.)

THERE is just now going on a good deal of talking and writing respecting the use of electric motors on standard railroads, especially for urban traffic, and there are a good many reasons why the system is preferable to steam locomotives, but in most cases those writing and speaking of the matter call it electricity superseding steam power.

Any innovation of the kind will be sooner understood and adopted if people would stop talking of "electric motive power." An electric motor on a locomotive represents the boiler and engines, which we may say, are taken from the engine and placed in a station, from which the power is sent out to the engine through the motor. In this manner, it is a problem admitting of generalization to a great extent and does not work out at all, as is popularly imagined. For example, one hears that we will soon have electric locomotives, and the tons of dead weight now carried can be dispensed with. This is another mistake. The tons of dead weight are an essential part of a locomotive, performing an indispensable function, and if the steam power is removed, an equivalent weight of something else must be added.

There enters also into the problem a principle in mechanics which is sometimes called inter-dependence, and a very important one in this case. An automobile machine,

* Derval, "Navigation aerienne," 1889, p. 185.
† Langley, "Experiments in Aerodynamics," p. 40.



FIRST-CLASS BATTLE-SHIP "ROYAL SOVEREIGN," FOR THE ENGLISH NAVY.

like a steam locomotive, is independent within itself, and not dependent on other engines. The disablement of one engine extends no farther, and need not disturb the traffic of a road beyond the train it is drawing; but if the power is centralized or distributed from a station, then the whole traffic of a line depends upon the maintenance of the generating plan.

A cable railroad or an electric one, compared with a steam or horse-car route, illustrates the matter. When the cable or the current stops the whole traffic is suspended, but the traffic drawn by horses or steam goes on without liability to such detention. On the other hand, we have the inefficiency of the horse system, the danger, smoke and heat of the steam one, so the final end, or "survival of the fittest," must be left to time and evolution, despite the prophecy of tho-e who proclaim the substitution of steam with what they call "electrical power." Wholesale predictions of sweeping change, as said in the beginning, only discourage and hinder progress in the advancement of electrical methods that are now giving promise of wide application in what we call standard devices.

THE LARGEST BATTLE SHIP.

THE illustration given herewith, which is reduced from a very handsome engraving in the London *Engineer*, shows the new battle-ship *Royal Sovereign*, which is one of the largest—if not the largest—fighting ships yet built.

The *Royal Sovereign* is 380 ft. long, 75 ft. beam, has a mean draft of 27 ft. 6 in. and a displacement of 14,260 tons. She has an armor belt 18 in. thick and 250 ft. long, and a protective deck 3 in. thick, besides heavy armor protection for the guns in the central barbette. She has twin screws, each driven by a triple-expansion engine with cylinders 40 in., 59 in. and 88 in. in diameter. On trial these engines have developed 9,400 H.P. with natural draft and 14,000 H.P. with forced draft, the respective speeds reported being 16.77 and 18 knots. The ordinary coal capacity is 900 tons, giving a cruising radius of 5,000 knots at a 10-knot speed.

The armament consists of four 67-ton, 13½-in. guns mounted in pairs in the barbette; ten 6-in. rapid-fire guns; sixteen 6-pdr. and nine 3-pdr. rapid-fire guns; eight small machine guns; two 9-pdr. field guns; seven torpedo-tubes, three of which are submerged. The 67-ton guns are 23 ft. above the water, the ship having about 19 ft. freeboard; they carry a projectile weighing 1,250 lbs., with a powder charge of 630 lbs. These guns can be given about 13° elevation and 5° depression, and have an arc of fire of 240°; they are worked by hydraulic gear. The torpedo-tubes will carry an 18-in. torpedo.

The ship has electric light apparatus and all the latest improvements in ventilation, etc.; it is stated that the accommodations for officers and crew are better than in most modern battle-ships.

On the speed trials, in an eight-hour trial an average of 16.77 knots an hour was reached with natural draft. With forced draft 18 knots were made, but this trial was cut short in the fourth hour, serious leaks having developed in a number of the boiler tubes. The forced draft trial is to be repeated when the necessary repairs to the boilers have been made.

The *Royal Sovereign* is a very formidable ship, and she is also a much more manageable vessel than some of the other English battle-ships, which have hardly been a success in manœuvering. Her appearance, as shown by the cut, is certainly very handsome.

THE FUTURE DEVELOPMENT OF ELECTRIC RAILROADS.

(From the address of President Frank J. Sprague, at the Chicago meeting of the American Institute of Electrical Engineers.)

AMONG the roads which are ripe for the electrical engineer, and on which, in the near future, I hope he will demonstrate he has a most legitimate claim, are the New York Elevated and the Chicago Elevated, the handling of the trains on the New York Central and Harlem roads below the Harlem River, the long-talked-of rapid transit road of New York, the Metropolitan Underground road of London, the proposed tunnel roads in London, Paris, and Berlin, and, coming more immediately home, suburban service, such as that of the Illinois Central Railroad—a most ideal track for the electrical engineer; and last, and as it will prove, one of the most important, the operation of terminal and warehouse systems for the interchange of freight on the lines entering a city situated like Chicago.

Taking this last, we have here a definite problem, now performed in a more or less satisfactory way by steam service. It is a problem large enough of itself. It has little connection with electric trunk-line service, and the present impracticability of the latter has little bearing upon the thorough practicability of the former. Eighteen hundred, or more, switch engines, many of them on duty twenty-four hours a day, a large portion of the time standing idle, puff their foulness into your overburdened atmosphere, because from 80 to 90 per cent. of all the freight that comes into the depots of this city ought never come inside its limits, and would not, were there a practical way provided to distribute it from one railroad to another outside the city limits. It has been suggested, and it seems to me a most feasible plan, that there shall be established a vast system for interchanging freight on the various railroads by a great six-track crossing belt road, which shall form a common zone of transfer either by itself or in combination with freight warehouses or storage yards. Undoubtedly there are many difficulties in the way, but from an electrical standpoint there is absolutely no question but that such a system of belt line is practicable.

With such unsolved problems, such abundant fields, I deem it unnecessary now to attempt to build electric locomotives to pull trains of great weight 100 miles an hour, or to develop a system of conductors for trunk-line service which is not possible for yard duty, or to consider a central station or track equipment for a duty never required. This problem is in a measure an experimental one, which, being carried to a certain measure of success, will clearly point the way for future development and outline its limits.

I may be pardoned, perhaps, if I take radical views in some matters of railroad practice. I have fortunately, or otherwise, been thrown into direct touch with all the larger work which is to be done in this country during the coming year, and it gives me pleasure to announce what many of you know from the current news of the day that there will probably be in operation in the United States within 12 months not less than five locomotives varying from 700 to 1,200 H.P. and from 45 to 80 tons in weight. The character of the work done will vary. In that work which I am most concerned with from a personal standpoint, a 700-H.P. electric locomotive will be built for experimental work, and to attempt to solve, as far as may be, the various problems which are involved in railroad practice in Chicago. If my judgment is followed, there will be an experimental section of track in the form of a loop about 13 miles long, with 18 miles of rail, and with every variety of single and double track construction and simple and compound crossings and switches.

On this I hope to see erected such varieties of overhead construction as may be found best to meet the various kinds of service, and where the railroad problems on track jointly operated by steam and electricity can be developed in the most satisfactory manner. On this track there will be not only this locomotive but also one of equal rated capacity supplied by one of the larger manufacturing companies.

The duty demanded of these machines will be severe. They will be required to haul a train of not less than 450 tons at 30 miles an hour up a grade of 26 ft to a mile. They will probably be required to develop their full rate of capacity at all speeds between 30 and 60 miles per hour, and if there is sufficient track-room they will be driven at speeds of at least 75 and perhaps 100 miles per hour for short distances. The potentials used will be nearly double that at present obtained in street railroad practice.

A still larger problem, so far as power goes, although not in the variety of conditions which will have to be met, will be that recently taken for the operation of the Belt

Line tunnel now being constructed in Baltimore to avoid the necessity of boat transfer at Locust Point. The duty of the motor here will be to propel the train with engines coupled on but not in operation through a tunnel about 6,000 ft. long. The conditions require motors which will weigh about 80 tons, and have a capacity of about 1,200 H.P. to propel a 1,200-ton freight train up a grade of 42 ft. to the mile at a speed of 15 miles per hour. Passenger trains of 450 tons' weight must be regularly started from rest twice in the tunnel on this grade, and in an emergency the motors must start the freight train. The draw-bar pull under regular duty, and when not starting, may be as high as 32,000 lbs.

Perhaps the traffic from New York to Philadelphia affords as good an example as any of what may be done on regular passenger service, provided the track is clear enough. For this, I some three years ago, and again in the *Forum* of September, 1891, outlined an electric express service with a method of supply through a rod carried above the car and a return circuit through the rails and earth. The current was to be supplied from one or more central stations equipped with high-class triple-expansion engines driving multipolar dynamos directly coupled. What the electrical engineer and the railroad men as well needs to know is whether the electromotice force required on the line and the number of stations necessary would be prohibitory.

No attempt was made for an excessive speed, but I confined myself to the average speed of a mile a minute for a distance of 90 miles, and considered a through service only. I assume a total weight of copper of only about two-thirds that which exists on the long-distance telephone line between New York and Boston. The trains were to be two-car units leaving every ten minutes.

I found with these conditions the stations and potentials would be about as shown in the following table :

Stations.	Miles apart.	Potential.	
		Two-wire.	Three-wire.
1	—	3,600	1,800
2	45	1,800	900
3	30	1,200	600
4	22½	900	450

If the three-wire system is used—that is, the rails as a compensating conductor between two trolley roads—then with only two stations 45 miles apart it is seen that the potential is less that 1,000 volts, and this we undoubtedly can handle.

I am not prepared to say that we may not use even a higher pressure, because I believe whatever is demanded in the interests of economy, all things being considered, will be used, but if we can reduce the potential to perfectly safe and reasonable limits by multiplying the number of stations, then those stations should be increased so long as the increase does not seriously affect the general expense of working. On a service of this character, where I have made the conditions, distributed work and the dispatching of units at brief intervals—which conditions, I repeat, are absolutely necessary if we are to consider long-distance transportation by electricity—such increase of stations as is advisable will not increase the cost of central station operation.

Such is the work before you—a work well meriting your best efforts, yet it is well to temper your enthusiasm with prudence. Limit your attempts to the solution of those problems which will prove of practical benefit. Remember that neither sentiment nor ignorance, but lessened costs of operation for equivalent duty and increased returns on invested capital are winning cards.

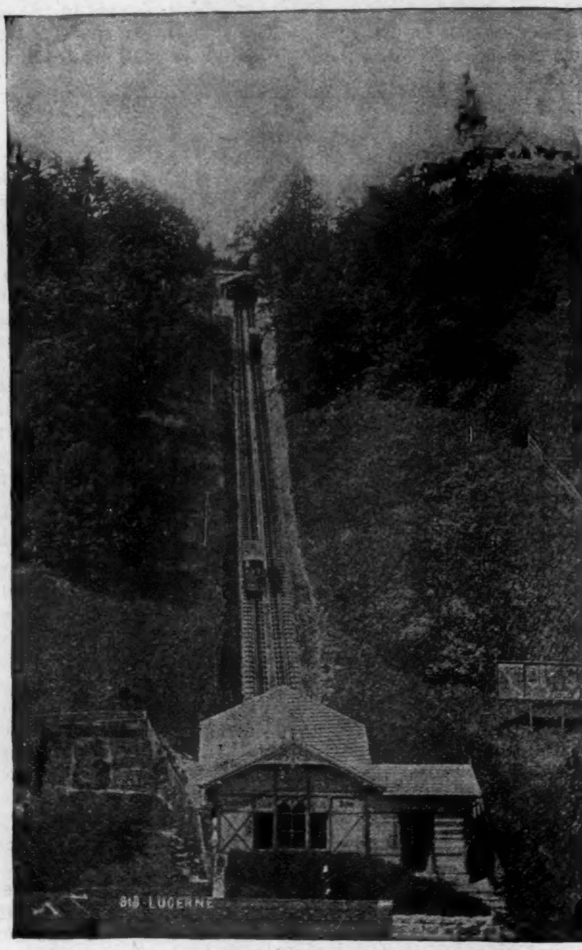
All this is said in no spirit of discouragement, for I yield to no man in my confidence in the future of electric traction. No new field is so rich, none more pregnant with great possibilities ; but the growth of the work will be more expeditious and healthy if we separate the visionary from the real, the impracticable from the practicable.

SOME SWISS RAILROAD NOTES.

FROM AN OCCASIONAL CORRESPONDENT.

THERE are many street railroads in Switzerland where steam is the motive power. Some of these serve a double purpose, for in addition to level road work they climb the hill and mountain sides to the points where the specially designed mountain roads begin. A number of the street railroad motors or locomotives are therefore built to work over a rack-rail as well as on a level.

Some of the mountain roads have extraordinary grades. The Glion line, near the Lake of Geneva—which is a cable road—has an incline of 57 per cent. The majority of the roads, however, vary between 50 and 25 per cent. grades. The number of these roads is increasing, and it is probable that before many years there will be a railroad part of



THE GUTSCH CABLE ROAD AT LUCERNE.

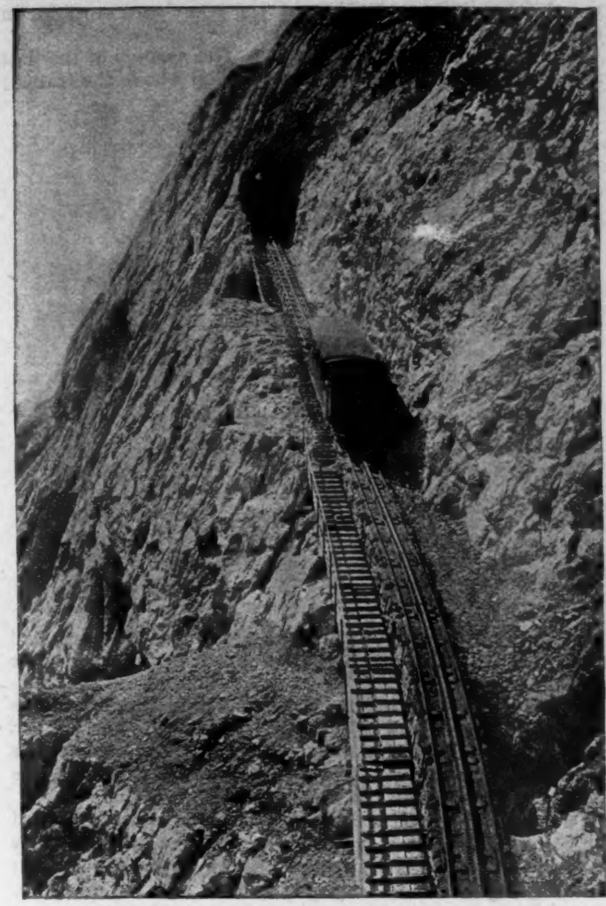
the way up Mont Blanc, though there are some tremendous difficulties to be overcome.

The illustrations given are from photographs by Jullien, of Geneva. One shows the Gutsch road at Lucerne. This is a cable line, and is almost the only one of the mountain roads having a double track.

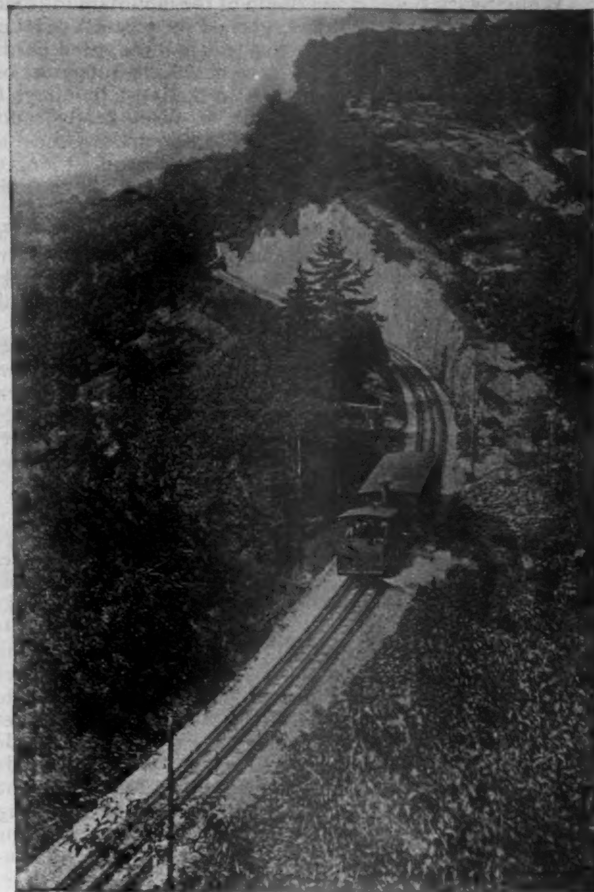
The second shows a view taken on the rack-railroad up Mont Pilatus, which is worked by locomotives ; it well illustrates the wild nature of the scenery, and some of the engineering difficulties which had to be overcome.

The third is a view on the Righi Railroad, also a rack-rail line worked by steam ; while the fourth shows the lower terminus of the Righi road. The appearance of the locomotives, built to work on an incline, is peculiar when they are brought down on a level, as in this view.

A variety of engines are used on these roads. A very common form has a vertical boiler set on a bare platform or frame which carries the cylinders and other machinery.



VIEW ON THE PILATUS RAILROAD.



VIEW ON THE RIGHI RAILROAD.

LOWER TERMINUS OF THE RIGHI RAILROAD.

The boiler is usually set at an angle so as to carry the water properly on the road.

While Switzerland is the home of the mountain railroad, and the country where it has reached its greatest development, the traveler from America will find the speed hardly satisfactory. Most travelers have noted the difference between the quick-moving elevators in the large buildings in New York and Chicago and the tortoise-like hydraulic "lifts" of European hotels. The difference is almost as great on the mountain roads, making the tourist long to get out and push, or, at least, to get over the ground faster by walking.

The ordinary roads make reasonably fast time, but the mountain roads have not the spur of competition to hurry them. The cost is so great that no one would undertake to build a second line, and the management is as economical as possible.

Nevertheless, these mountain roads are a great benefit to tourists, and have very much reduced the labor of seeing the mountains. Perhaps too much ought not to be expected of them, and they fill the demand reasonably well. Still they are slow to make improvements; and a traveler cannot help thinking that were the Righi in New York State better time would be made up its sides.

ON my last visit to Switzerland, when passing through the second longest tunnel in the world—that which pierces Mont Cenis—I made as careful an inspection as possible from the carriage window, to see what it was looking like after twenty years' service. The entry to the eight-mile tunnel from the Italian side is fittingly monumental and impressive, huge stone columns supporting the arch over the portal. Once in the tunnel the train continues to mount slowly for half a mile; then come about four miles of level grade, then suddenly begins a steep down grade for the remaining three and a half miles. When this grade begins the train is for a few minutes in violent flight, the speed being fearful; the brakes are applied hard, causing showers of sparks to fly off from the wheels, so that the tunnel is for the moment almost lighted up. The steam-brakes used soon fill the tunnel with grit-laden vapor. About this point a train is usually met struggling up the steep grade.

The Mont Cenis tunnel is one of the dirtiest in the world. One cannot look out of the window for a few minutes without getting covered with soot and grit. The air in the tunnel is very unhealthy; there is the cold damp which has been there from the beginning, making the place feel like an ice-house. The ventilation is very defective, and the artificial illumination very poor. The carriages are very poorly lighted also, and the speed at which trains pass through is low. It takes about half an hour to go through, so that it is a very tedious transit.

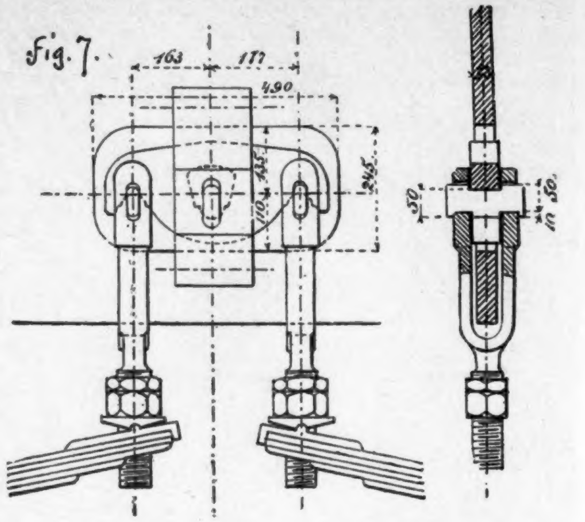
A RUSSIAN FREIGHT ENGINE.

THE drawings given herewith show a tank engine for heavy freight or pushing service which is illustrated and described in a recent number of the *Journal* of the Society of Russian Engineers. Fig. 1 is a side elevation; fig. 2, a longitudinal section; fig. 3, a half cross-section; fig. 4, a half front view; figs. 5 and 6 are half plans, one with the boiler removed. The dimensions on the drawings are in meters.

The engine is carried on eight wheels, all coupled. The cylinders are outside, but the steam-chests are inside. The boiler is of the straight topped type, the fire-box crown-sheet being arched and supported by stay-bolts extending to the outer crown-sheet. The boiler barrel is 57.9 in. in diameter, and has 212 tubes 12 ft. 1.6 in. long. The fire-box is shallow, and is raised entirely above the axles, as shown in fig. 2. The grate area is 19.9 sq. ft. The saddle under the smoke-box is of iron plate, the cylinders being attached at the side, as shown in fig. 3; this is a very common arrangement in Russia and Germany, where the cast-iron saddle is not favored. The heating surface is: Fire-box, 98.5; tubes, 1,356.3; total, 1,454.8 sq. ft. The working pressure is 150 lbs.

The cylinders are 19.7 in. in diameter and 25.6 in. stroke. It will be noted that the old arrangement of continuing the piston-rod through the front cylinder-head is still carried out in this engine. The valve motion is of the shifting link type. The driving-wheels are $47\frac{1}{4}$ in. in diameter.

The frame is of the plate type. The springs of the first and second pairs of wheels are carried above the frame;



those of the third and fourth pairs are below the axles, and are equalized by an arrangement shown on a larger scale in fig. 7.

Water is carried in two side tanks, and coal in a box placed in the rear end of the cab. The engine has at each end the double buffers and screw couplings in general use on the Russian roads. The cab is entirely closed in, the engine being arranged to run in either direction.

The total wheel base is 12 ft. 9 in.; the total length of the engine over all is 33 ft. $1\frac{1}{2}$ in. The total weight is 124,746 lbs., which is divided as follows on the four axles: First, 31,032; second, 31,209; third, 31,429; fourth, 31,076 lbs.

The general construction of the engine and many of the details can be very clearly seen from the drawings.

NOTES ON A PROBLEM IN WATER POWER.

(Paper read before the American Society of Mechanical Engineers at the meeting of May, 1892, by John Richards, of San Francisco.)

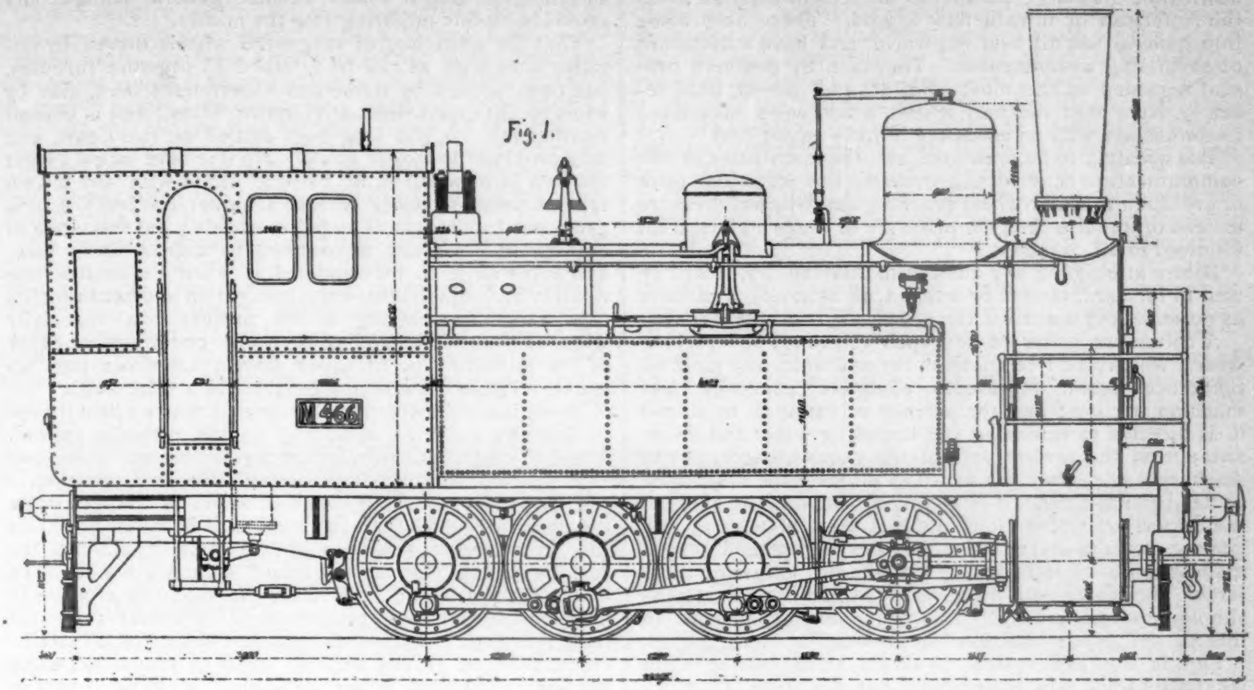
THE present paper is to be a non-scientific one, and in other respects is not to be classified among the contributions such as are commonly presented before this Society. Neither are its objects the same. The purpose is to present some thoughts upon a very important subject, with a view to calling out further and more able discussion. There being nothing exact or determinate to deal with, there will be neither figures nor quantities included, so that no severe mental strain need be apprehended in following the remarks.

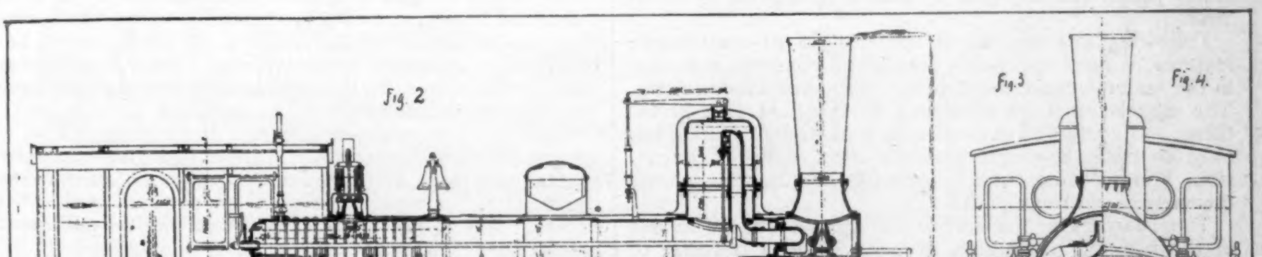
The subject is Water Motors, or, as we commonly say, Water Wheels, for utilizing the action of gravity of water, and an inquiry into the probable conditions, inferences, or deductions which have led up to and established modern practice as it now exists in this country.

Water wheels, as we have to deal with them, may be classed as gravity wheels, including (1) overshot breast wheels, and perhaps the Poncelet type; (2) pressure wheels, including what we call enclosed turbines and reaction wheels; (3) impulse wheels, driven by spouting water.

The classification thus assumed is, for short: gravity, pressure and impulse wheels. These may be said to cover the various types in common use.

In modern practice the class called pressure turbine wheels constitute perhaps four-fifths of the whole. These can be divided into three general types—namely: The Fourneyron, or outward radial discharge; the Jonval, or





A HEAVY RUSSIAN TANK LOCOMOTIVE.

downward discharge parallel to the axis of rotation; and the American or inward flow wheels. These have come into general use all over the world, and have a literature of surprising completeness. They are by common consent regarded as the most efficient, and, indeed, until recently, have been the only wheels which were considered in connection with an efficiency beyond 60 per cent.

The question to be presented and the main point in this communication is, what has produced this particular form of evolution in water-wheel practice, and why has pressure instead of impulse been the principle or mode of operation followed in all countries?

Before attempting any answer to this inquiry, it will be well to further examine or explain, in as simple a manner as possible, the nature of the class called turbine wheels.

A column of water resting upon the vanes of a turbine wheel, which are free on their reverse side, and meet no resistance there, represents complete efficiency less machine friction; and the science of turbines, to so call it, is directed to removing the impeding water and its resistance on the reverse side of the vanes—that is, on the discharge side, after the function of pressure has ceased or has been utilized. It is common to divide the effect of the water, or its functions, in this class of wheels, into gravity, impulse and reaction, but there is no need of such assumption or of introducing the complex nature of these forces thus combined, because the whole is explained as simple pressure, and all observed phenomena point to this as the "mode of action" in pressure turbines.

I am in this assumption, no doubt, transgressing upon what are called established data, but the issue is not important to the present subject, and it will be sufficient to call the active force one of pressure alone, and the resistance or loss a result of the imperfect riddance of the water on the reverse or discharge side of the vanes, after it has performed its work by pressure, impulse or otherwise.

Following this method of operating to its constructive features, it involves closed vessels, or conduits, not only to the water wheels, as in other cases, but around them. The wheels must be enveloped in the fluid that drives them, and contained in cases strong enough to sustain not only the static head, but also the effect of water concussion, and in most cases afford support for the wheels themselves and their shafts.

The bearings of the wheels have to sustain the weight of the running parts, also, in many cases, a pressure of the head equal to area of the issues multiplied into the head. The wheels are submerged, placed at the bottom of the head or near it, inaccessible to observation, and also for repairs, calling for unusual and expensive provision in the way of bearings and other constructive features, including extra strength of all parts. The hydrodynamic conditions both of entrance and discharge call for complicated forms that cannot with safety be built up, and pressure turbine wheels in this way become large and expensive castings, the value of which depends upon the integrity of every part. If a vane be broken or imperfect, the whole wheel is lost. The diameter being limited because of first cost, a limit of rotative speed is reached at a head of 50 ft. or so, and even at that head the bearings have to run under undesirable conditions; in other words, this type of wheels does not permit control of rotative speed, that being limited by both first cost and operating conditions.

Turning now to the other type of wheels, but little known in this country, except on the Pacific Coast, the impulse class, and assuming that the force of spouting water is equal to its gravity less an inconsiderable friction in orifices, the question arises, why has not the evolution of water wheels followed on this line instead of pressure for all except low heads?

This is a very important question, one that may well engage the attention of this Society, and one that calls for explanation such as will be by no means easy or apparent. It is true that with that class of impulse wheels called "undershot," and some other cruder forms operating by the impulse of spouting water, the efficiency attained has been so low as to lead to the conclusion that the losses were inherent in the method or mode of operation, and this opinion has, it seems, become general without any one very closely inquiring into the matter.

That the efficiency of tangential wheels driven by impulse is as high as can be attained by pressure turbines, has been proved by numerous experiments here, also by some recent experiments at Holyoke, Mass., and is beyond controversy. It has long been settled on this Coast, and as a problem no longer exists. No one here would expect under a head of 50 ft. or more to attain with any known type of pressure water wheels a higher efficiency than is given out by tangential impulse wheels; but this state of opinion and practice is confined to narrow limits now, and is the more to be wondered at when we consider the rapidity and completeness of investigation in other branches of dynamic engineering at the present day, especially when the economic and constructive conditions in favor of the impulse type of water wheels are taken into account. These we will now consider in a brief way.

There is a wide difference between a water wheel driven by impulse and one operating on the pressure system. The first cost of the former, for a given power, is one-half as much, and its maintenance is still less, in proportion.

Figuratively speaking, when a wheel is changed from the pressure to the impulse system, it is taken out of its case, mounted in the open air, in plain sight. All the various inlet fittings are dispensed with and are replaced by a plain nozzle and stop-valve. Its diameter is made to produce the required rotative speed, whatever that may be. The shaft and its bearings are divested of all strains except those of gravity and the stress of propulsion when the water is applied at one side only. Most important of all there are no running metallic joints to maintain against the escape of water, no friction and no leaks; there are, indeed, no running joints or bearings whatever, except the journals of the wheel shaft.

The effect of grit and sand is eliminated, both as to vanes and bearings, and there are no working conditions that involve risk or call for skill. If a vane is broken, another one is applied in a few minutes' time. If a large or small wheel is wanted, the change is inexpensive and does not disturb the foundations or connections.

Capacity is at complete control; the wheels can be of 10, 100 or 1,000 horse power, without involving expensive special patterns. The speed of rotation is not confined to commercial dimensions because of patterns and other causes. It is merely a matter of choice with the purchaser or maker.

Now granting the efficiency of impulse wheels, which, as before remarked, can hardly be called in question for all heads exceeding 50 or even 30 ft., and conceding the constructive and operating advantages just pointed out, the question at first named rises, why has the evolution of water wheels during 50 years past been confined to the pressure class? Also, why has it been proposed at Niagara Falls to employ pressure turbine wheels under a head of 100 ft. or more, when the conditions point to the better adaptation of open or impulse wheels?

It is not necessary in such an inquiry to discuss the problem of horizontal and vertical axis, or other local conditions, in the case of the Niagara plant, or in any other, further than to say that the pressure class of wheels offers no advantages not balanced by equal or greater disadvantages, as will no doubt appear if there should be discussion of this subject before the Society.

Besides the object of this communication first named, there is the further one of calling the attention of the members present to the impulse or open water wheels so extensively employed on this Coast, and to suggest that, if possible, they manage to see such wheels in operation under various heads, especially under high heads. In observing a machine of any kind in motion, there are impressions gained which cannot be conveyed by description, but I warn every one against inference from this remark that the tangential water motor wheels on this Coast are not scientifically understood and treated. The problems involved may not be so many or so intricate as in the case of pressure turbine wheels, and this is fortunate, because the literature of the latter is one of much complexity to any but skilled mathematicians, and for that reason has not been of so much use as it ought to have been.

In this country, and it is a most commendable thing to mention, the pressure turbine by an inward flow, or an inward draft, has been greatly simplified in construction, cheapened in first cost, and at the same time better adapted to impure water, without losing anything in efficiency. I believe the inward flow turbines made by the Risdon Company at Mount Holly, N. J., have in public tests on more than one occasion shown an efficiency as high, or even higher, than the more finely fitted Fourneyron and Jonval types.

The record of American engineers in this branch is one of which they may well be proud; and now that impulse wheels of the Girard type have made much progress abroad, and have here in California been modified much as the Fourneyron and Jonval wheels have been in the Eastern States, it is quite time more attention was bestowed upon the subject in other parts of the country. Analogy in the two cases is marked. By an inward flow, American makers reduced the running parts, or the wheel proper, of pressure turbines to a small diameter, increasing its speed accordingly. This lessened the weight and cost of the wheels in the proportion of their diameters, and at the same time dispensed with the accurate fitting involved in the outward and downward flow turbines; and this, as before said, has been done without sacrificing efficiency.

The tangential type of open wheels has been similarly dealt with here in California. The running-water joints have been wholly dispensed with. The construction has been cheapened one-half. The round jet has been applied in the most simple manner, with an increased dynamic effect, and the efficiency attained is believed to be more than is reached by the finest examples of Girard wheels in Europe.

Conceding these statements and facts brings us back again to the query forming the subject of this communication—namely, Why has the evolution of water wheels followed on the line of *pressure* instead of *impulse?*

VIADUCTS ON THE BOMBAY WATER WORKS.

(From *Indian Engineering.*)

THE annexed illustrations will have an interest in connection with the opening ceremonial about to take place of one of the largest water-supply projects ever undertaken in the world; we refer to the Tansa Scheme for the City of Bombay, just completed by Mr. W. Clerke, who has *engineered* the undertaking from first to last.

Through the courtesy of Mr. Clerke, we are enabled to give two views of the Duct. Fig. 1 is a view of the bridge over the main channel of the Bassein Creek. Fig. 2 is a view of an aqueduct near the Vehar Lake.

The bridge which carries the Tansa 48-in. pipe over the main channel of the Bassein Creek, which separates the island of Salsette from the main land, is situated at 32 miles on the Duct line from the outlet works at Tansa. It consists of 15 spans, 100 ft. centers, with a gradient of 1 in 40 from each end to the center span which is horizontal. This span gives a clear headway of 22 ft. over high water spring tides. Each abutment and pier consists of a pair of cast-iron cylinders 5 ft. diameter up to low water spring tides. At this level they reduce to 4 ft. diameter by a taper piece. Each cylinder is sunk to rock level, and some of them are 75 ft. under surface of ground. They are filled with lime concrete, and each pair of cylinders is braced together from low water spring tides upward by wrought-iron horizontal and diagonal bracing. The superstructure consists of wrought-iron lattice girders 18 ft. apart centers. The girders are 9½ ft. deep. The lower booms carry cross girders of rolled beams laid 9½ ft. apart. The bridge is designed to carry two lines of 48-in. pipes, one on each side close to the main girders, and a line of tramway 2½ ft. gauge in the center. Only one line of pipes is at present laid. Two smaller bridges, each of four spans and of similar construction, carry the pipe line over two smaller channels of the Bassein Creek.

The aqueduct shown in fig. 2 carries the masonry conduit along the ridge to the east of the Vehar Lake. It is situated at 41 miles on the Duct line from the outlet works at Tansa. The aqueduct consists of 15 spans of 20 ft. with three arches of 10 ft. span at the north end and six arches of 10 ft. span at the south end. The greatest height from ground level to springing of arch is 20 ft. The aqueduct carries the masonry conduit, which is 7 ft. wide between the side walls and 6 ft. high to springing of arch. The arch has a rise of 15 in. and is 8 in. thick. There are numerous aqueducts of this type on the line of the Duct, but the one represented in the illustration is the largest and most important of its class.

FIG. 1.

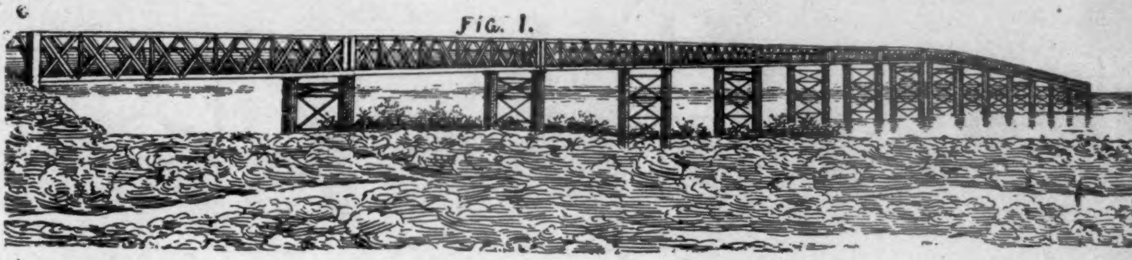


FIG. 2

VIADUCTS ON THE NEW WATER WORKS FOR BOMBAY, INDIA.

THE LIVERPOOL WATER-WORKS.

THE new water-works for the supply of the city of Liverpool in England were formally opened on July 14. These works present many interesting points; they consist of the dam and reservoir at Vyrnwy in Wales, and of an aqueduct 68 miles long—claimed as the longest in the world—carrying the water to the point of distribution near the city.

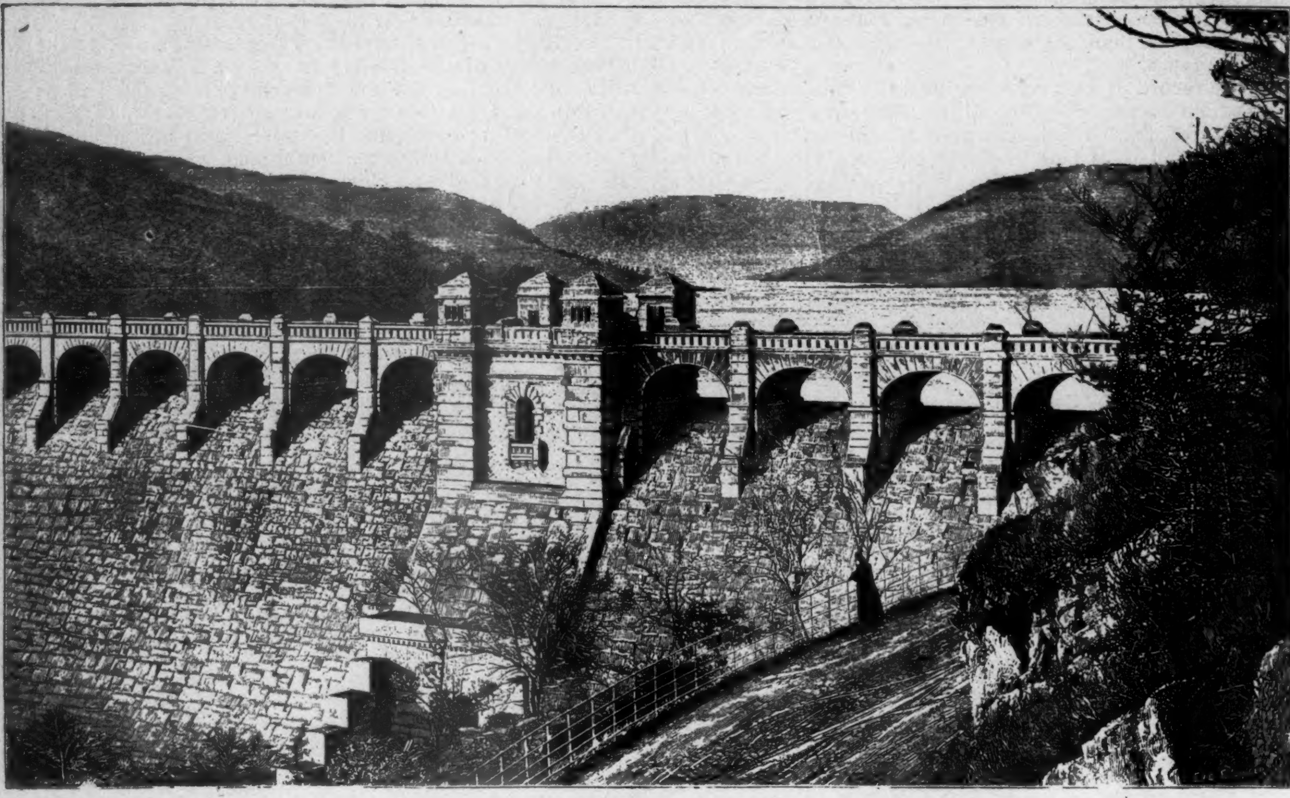
For the facts given in the following condensed account, and for the illustrations, we are indebted to an interesting and complete description given in the London *Engineer*.

The starting-point of the new water-works is at Lake Vyrnwy, in the mountains of Wales, where a lake with a storage capacity of 12,131 000,000 ga lons has been made by the erection of a fine masonry dam across the valley. The water is collected from a drainage area where there is a large rainfall, and all the circumstances favor the purity and excellence of the supply The storage capacity is so great, that a failure or deficiency in the supply is hardly possible under any circumstances.

The Vyrnwy River is a tributary of the Severn, and at the point selected for the great reservoir flows through a deep valley where the conditions are exceptionally favorable. The lake or reservoir formed by the dam is 4.75 miles long and varies in width from 0.25 to 0 625 mile. The dam itself is 1,172 ft. in length, from the rock on one side of the valley to that on the other. It is 161 ft. high in the center from the foundation to the parapet of the roadway crossing it. The height from the river-bed is 101 ft. to the parapet and 84 ft. to the sill over which the overflow passes—that is, between the arches supporting the roadway. The greatest thickness of the dam at the base is 120 ft. and the width of the roadway on top is 19 ft. 10 in. The batter of the front or water-face of the dam is 1 horizontal in 7 27 vertical; the slope of the back of the dam above ground level is 1 in 1.5.

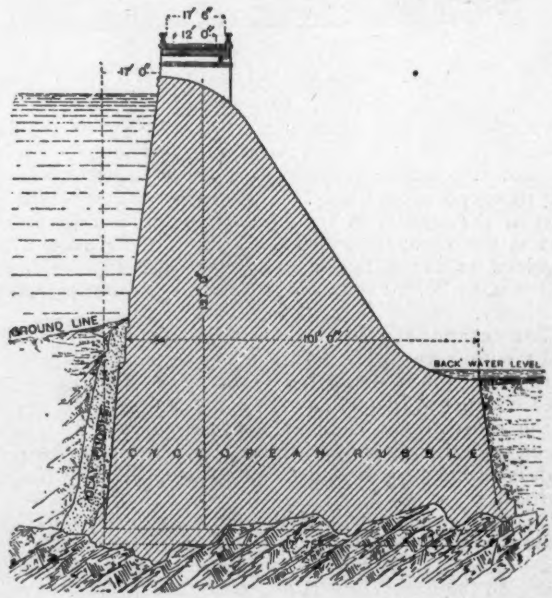
A general view of the dam is given herewith, which gives an excellent idea of its appearance and the surroundings of the lake. A cross-section of the dam is also given.

Water is drawn off to the aqueduct through a tower placed at the side of the lake, and provided with special arrangements for taking it at the best level to secure purity and to prevent silt or solid matters from entering the pipes. A view of this tower, which is very picturesque in design, is also given.



THE VYRNWY DAM.

The aqueduct is 68 miles in length from Lake Vyrnwy to the Prescot Reservoir, which is nine miles from the Liverpool Town Hall. It is designed throughout for three lines of pipes having a total capacity of 40,000,000 gallons per day; but at present only one of these lines is laid, carrying 13,333,000 gallons.



SECTION OF VYRNWY DAM.

The aqueduct commences with the Hirnant Tunnel 2.375 miles long, at the outlet of which the water enters

the pipes, which are carried underground for seven miles, except for a short distance, across the Aton, where they are carried over a bridge. The other streams on this section are passed by inverted syphons. This section ends at the Parc-Uchaf balancing reservoir, which is on a hill rising nearly to the hydraulic grade.

From this point follow 6.125 miles of pipe; then the Cyninion Tunnel, 0.875 mile, a bridge over a narrow valley and the Llanforda Tunnel about a mile long. The latter discharges into the Oswestry balancing reservoir, which is the largest on the line. The local conditions being favorable, this was made also a storage reservoir, where a supply of 46,112,000 gallons is held to provide for emergencies. About 0.75 mile farther on are the sand filtration beds and a clear-water reservoir with a capacity of 2,812,500 gallons. Two others, of equal capacity, are to be provided when the full capacity of the aqueduct is needed.

From the clear-water reservoirs to Malpas, 17.625 miles, the pipes are underground, except at Wych Brook, which is crossed by a bridge of masonry. Two branches of the Great Western Railway and the Shropshire Canal are passed in subways on this section, which ends in a balancing reservoir on Oat Hill. From this another section of underground pipe, 11,625 miles long, leads to the Cotebrook balancing reservoir.

From Cotebrook 11 miles of underground line extend to Norton Hill. On this section the River Weaver is passed by three steel pipes laid in a trench dug out in the bottom of the river, to a depth of 21 ft. below the water-level. The pipes are covered and protected by a bed of concrete. In order to reach the hydraulic grade at Norton Hill the balancing reservoir there consists of a tower rising to a height of 100 ft. This tower is of masonry, and supports

INLET TOWER, VYRNWY WATER WORKS.

a steel tank 82 ft. in diameter and having the form of an inverted dome. The tower carries on its summit a heavy ring of cast-iron set in cement; upon this is a complete ring of turned steel rollers, 12 in. in diameter, and upon these rollers the steel flange of the tank rests.

This tower is of a striking design, as is shown in the accompanying illustration.

THE NORTON TOWER, VYRNWY WATER WORKS.

From the Norton Tower the last section extends for 10.375 miles to the Prescot Reservoir, which is the distributing reservoir for the city system. On this section is the most costly and troublesome work on the line, the tunnel by which the pipes are carried under the River Mersey. This tunnel was driven from two shafts and was built on the Greathead system; the south shaft is 46.5 ft. deep and the north shaft 52.75 ft. The tunnel itself is 805 ft. long, 9 ft. inside and 10 ft. outside diameter; it carries at present a single line of pipe, but is all ready to receive a second line when needed. The drainage and waste water of the tunnel is collected in a well, whence it is removed by pumps.

It may be added that the designing and construction of the works has been under charge of Mr. G. F. Deacon, who has conducted them from the beginning. The cost is given at $10,500,000, which seems very moderate indeed.

THE NICARAGUA CANAL.

In a lecture recently delivered before the Franklin Institute in Philadelphia, Mr. George W. Davis, General Manager of the Construction Company, gives the following summary of the work thus far accomplished, which may be taken as an official statement. It may be added that Mr. Davis' lecture contains a very strong plea for the canal and for the many advantages to be secured by completing it as soon as possible, and for retaining the control of it in this country:

The Company has gone to its work of building the canal in a plain, unostentatious, systematic manner, and although nearly all accomplished to date may be described as preliminary, yet a very important advance has been made. These results may be summarized as follows:

1. The completion of the final surveys for location and construction.

2. The subterranean examination of the strata requiring removal, by means of borings with the diamond drill.

3. The restoration of the harbor of San Juan del Norte

to the extent of securing an easy entrance to the port for vessels of 12 ft. draft.

4. The construction of extensive wharves and landing facilities.

5. The erection of permanent buildings for offices, quarters, hospitals, store-houses, shops, etc., having a floor area of an acre and three-fourths.

6. The building of a large number of temporary camps along the line for accommodation of employés.

7. The completion of a telegraph line permitting ready communication of the New York office with any part of the work.

8. The clearing of the canal line of timber for some 20 miles.

9. The completion of surveys for location and plans of construction of the railroad system, and the construction and equipment of 11 miles of this line.

10. The acquisition by purchase of the most valuable and powerful dredging plant to be found in America, under one management.

11. The fitting up and operation of this plant and the opening of nearly a mile of the canal.

12. The acquirement by purchase of the valuable and exclusive franchise for the steam navigation of the San Juan River and Lake, together with the extensive plant of the Navigation Company, consisting of offices, lands, steamboats, tugs, lighters, repair shops, etc.

13. And lastly, what is felt to be the most important result of all is the demonstration, secured by experience, of the salubrity of the climate, the efficiency of labor, and the sufficiency of the estimates of the Chief Engineer for the harbor and canal dredging and railroad work.

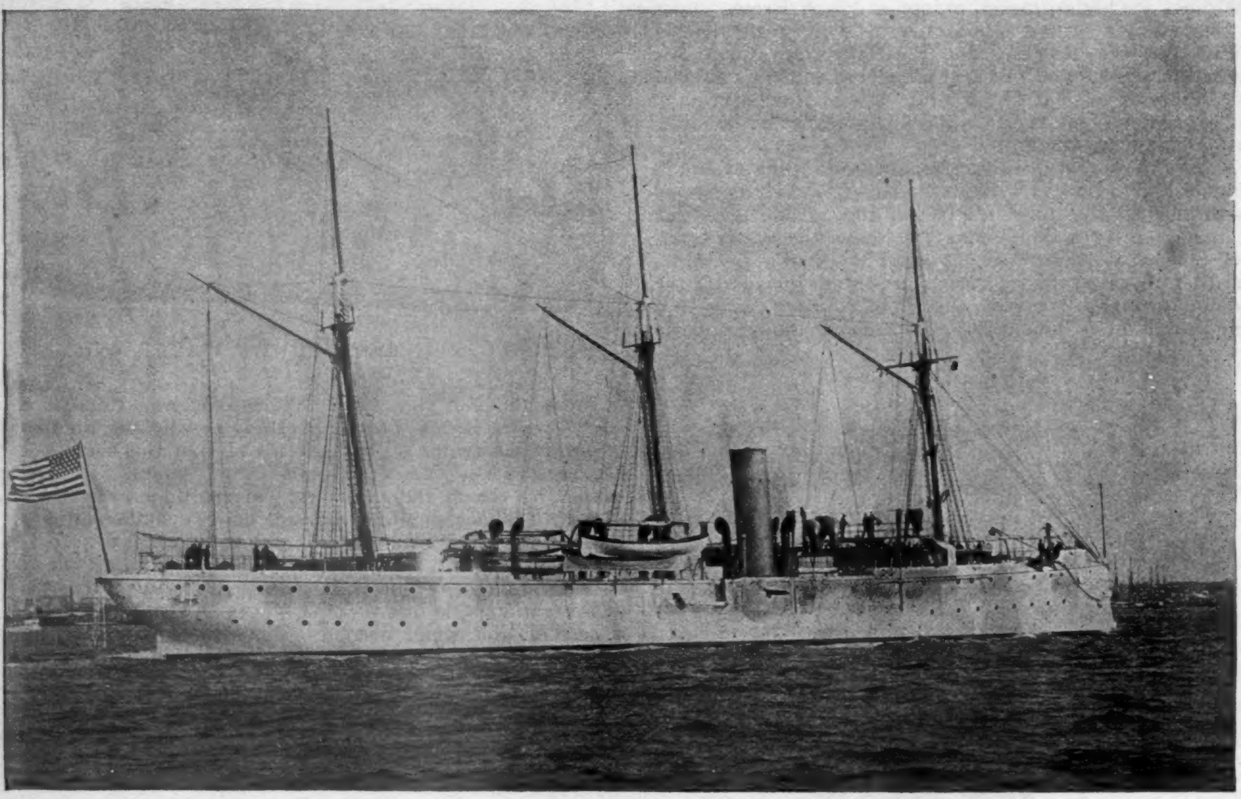
Finally, the Government of Nicaragua has formally made acknowledgment of the fact that the Company has fully complied with the requirement imposed by the canal grant, which provides that the work of construction shall not be considered as commenced unless $2,000,000 are expended in the first year. This formal acknowledgment confirms the Company's title to the concessionary rights for a term of 10 years in which to complete the canal and open it for traffic.

THE GUNBOAT "YORKTOWN."

THE accompanying illustration is from a photograph of the gunboat *Yorktown*, one of the smaller vessels of the new Navy. The *Yorktown* was built at the Cramp yards in Philadelphia, and was launched there April 28, 1888. She has now been in commission for some time, cruising in various waters, and has proved herself a useful ship. In appearance she is certainly a very handsome boat.

The *Yorktown* is a light, unarmored cruiser or gunboat of steel, divided by water-tight bulkheads into numerous compartments. The chief dimensions are: Length on load water-line, 226 ft.; beam, 36 ft.; depth, 18 ft. 9 in.; draft, 13 ft. forward, 15 ft. aft, or 14 ft. mean; displacement, 1,703 tons. The ship carries three masts with fore-and-aft rig, and has a sail area of about 6,350 sq. ft.

The *Yorktown* has two vertical, direct-acting triple-expansion engines, with cylinders 22 in., 31 in. and 50 in. in diameter and 30 in. stroke. The twin screws are three-bladed, 11 ft. 6 in. in diameter. Steam is furnished by four boilers, each 9 ft. 6 in. in diameter and 17 ft. 6 in. long. The engines work up to 2,200 H.P. with natural draft and 3,300 H.P. with forced draft, and the speed at full power is 16 knots per hour.



GUNBOAT "YORKTOWN," UNITED STATES NAVY.

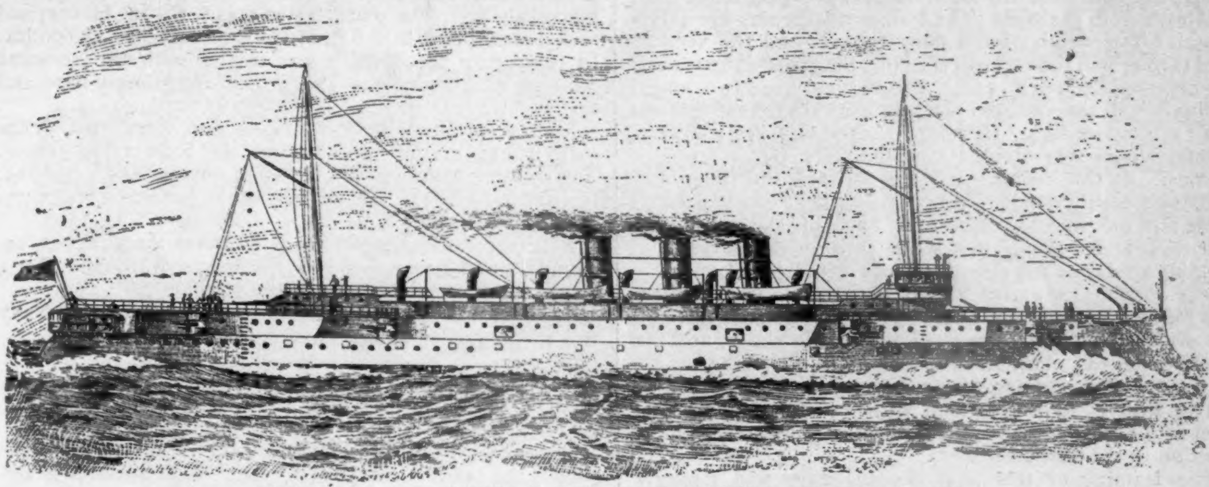
The main battery consists of six 6-in. rifled cannon, two mounted forward, two aft and two in sponsons amidships. All are mounted on central-pivot mounts, with segmental shields to protect the gunners, and have an arc of fire of 70°. The secondary battery includes two 57-mm. (2.24-in.) and two 37 mm. (1.46-in.) rapid-fire guns and one Gatling gun. There are also eight torpedo-tubes: one forward, one aft and six in broadside.

The ship is lighted by electricity, and has an electric search-light. Two independent light plants are provided. Especial attention has been given to ventilation of fire-rooms and quarters, and to providing comfortable quarters for the officers and crew, who number about 150 in all.

The *Yorktown* has two sister ships—the *Concord* and the *Bennington*—which are similar in almost all respects, but were built at the Roach yards in Chester, Pa., about a year later.

THE UNITED STATES NAVY.

THE launch of Cruiser No. 12—which has been popularly nicknamed the "Pirate," but to which the Navy Department has given the name of *Columbia*—took place at the Cramp yards in Philadelphia, July 28. This vessel has been heretofore described and illustrated, but we reproduce here a general description and a sketch made from the Navy Department plans. This shows the *Columbia* as she will appear when completed, except that it has been decided to add a fourth smoke-stack to the three appearing in the sketch.



CRUISER "COLUMBIA," FOR THE UNITED STATES NAVY.

The building of the *Columbia* was authorized by Congress in June, 1890, and the contract for building the ship was let to the Cramp Company in November, 1890. The plans for the ship were entirely prepared in the Navy Department.

The first keel plate was laid on December 30, 1890, and on March 21, 1891, the first frame of the ship was raised, the dimensions of the new vessel, according to the plans, being as follows: Length on mean load-line, 412 ft.; breadth of beam, 58 ft.; normal draft, 23 ft.; displacement, 7,550 tons; maximum speed, 22 knots an hour; indicated H.P., 23,000. As to speed, the contractor guarantees an average speed, in the open sea, under conditions prescribed by the Navy Department, of 21 knots an hour, maintained for four consecutive hours, during which period the air pressure in the fire-room must be kept within a prescribed limit. For every quarter of a knot developed above the required guaranteed speed, the contractor is to receive a premium of $50,000 over and above the contract price; and for each quarter of a knot that the vessel may fail of reaching the guaranteed speed there is to be deducted from the contract price the sum of $25,000.

Being intended chiefly for use as a "commerce-destroyer," and not as a fighting ship, she carries a comparatively light battery. It will consist of four 6-in. breech loading rifles, eight 4-in. guns, twelve 6-pdr. and 1-pdr. rapid-fire guns, four Gatling guns and six torpedo tubes.

The protection consists of an armored deck and of heavy steel shields for the guns. The coal-bunkers are also arranged so as to cover the machinery, and there is a coffer-dam along the ship's side which will be filled with woodite or cellulose.

The chief peculiarity of the *Columbia* is in the use of three screws instead of two, an arrangement which has been tried once or twice, but is new for a large ship. Each screw is driven by a separate engine; the engines are all alike, of the vertical, inverted, triple-expansion type, with cylinders 42 in., 59 in. and 92 in. in diameter and 42 in. stroke. It is expected that for ordinary cruising the central screw alone will be used, giving a speed of about 14 knots; with the two side screws alone a speed of 17 knots can be maintained, and with all three screws at work at full power a high speed of from 20 to 22 knots can be got out of the vessel. This arrangement will allow the machinery to be worked at its most economical number of revolutions at all rates of the vessel's speed, and each engine can be used independently of the others in propelling the vessel. The full steam pressure will be 160 lbs. There are 10 boilers, six of which are double-ended, 21½ ft. long and 15½ ft. in diameter. Two others are 18½ ft. long and 18⅞ ft. in diameter, and the two others, single-ended, are 8 ft. long and 10 ft. in diameter. Eight of the largest boilers are set in water-tight compartments.

The accommodations for officers and crew are spacious, well ventilated and will be well lighted. All the most modern improvements of appliances for exhausting the vitiated air and for incandescent electric lighting have been incorporated in the designs. The sub-divisions of the vessel are such as to form a double-hull below the water-line, which will offer great security against disaster from torpedo attacks.

A sister ship to the *Columbia*, at present officially known as Cruiser No. 13, is under construction at the Cramp yards.

THE HARBOR DEFENSE RAM.

The next ship to be launched is the harbor defense ram, known as the Ammen ram, from the fact that the design is due to Rear-Admiral Ammen. This ship has been built by the Bath Iron Works, at Bath, Me. We repeat here the general description of this ship, and a sketch made from the Department plans.

HARBOR DEFENSE RAM, UNITED STATES NAVY.

The principal dimensions of this vessel are: Length over all, 243 ft.; length on load water-line, 242 ft.; extreme breadth, 43 ft.; breadth at water-line, 41 ft. 10 in.; draft amidships, 15 ft.; displacement, 2,050 tons; indicated H.P., 4,800; speed, 17 knots per hour.

The vessel is designed upon the longitudinal and bracket system, with an inner bottom extending from the collision bulkhead to the stern. The longitudinals and girders supporting the deck are continuous, converging to the stem casting and to the stern; the frames and beams are intercostal. The depth of the longitudinals and the vertical keel throughout their length is 24 in.; the girders supporting the armored deck are 15 in. The vertical keel, two longitudinals, and the armored shelf on each side of the vertical keel are water-tight, forming transversely six compartments, which are divided longitudinally by water-tight frames. By this means the space between the inner and outer skin is subdivided into 72 compartments. The transverse and longitudinal bulkheads between the inner skin and deck armor divide this space into 30 compartments, making a total of 102 compartments in the vessel.

The deck armor varies from 6 in. to 2½ in. in thickness, and the side armor from 6 in. to 3 in. All hatches through the armored deck are furnished with battle-plates, and the smoke-pipe and ventilators are to have inclined armor 6 in. thick. The conning-tower is 18 in. thick.

The ship is to be provided with a removable wrought steel ram-head to be accurately fitted and securely held in position in the cast-steel stem.

The framing of this ship is very heavy and strongly braced. As shown by the illustration, the greater part of the vessel will be submerged, while nearly all of the surfaces appearing above water are curved, leaving no opportunity for a square blow from a shot. The ship will carry no armament, depending entirely upon ramming for her offensive strength.

The only projections above the deck are the conning-tower, the smoke-pipe, the ventilators, the hatch-coamings, and the skid-beams upon which the boats are supported.

The officers' quarters will be on the after berth deck, and the quarters for the crew will be partly aft and partly forward. There will be a complete installation of electric lights arranged in duplicate. The drainage system will be so arranged that any compartment can be pumped out by the steam pumps. Foul air will be extracted from all parts of the vessel by means of blowers, fresh air being supplied from the main ventilator, through air ducts led along the inside of the deck.

The vessel will be submerged to fighting trim by means of fourteen 8-in. Kingston valves, one in each transverse water-tight compartment of the double bottom. Sluice valves will be fitted in the vertical keel, and the water-tight longitudinals in these compartments.

The engines are triple-expansion and of the horizontal type, each being in a separate compartment. There are four cylindrical horizontal fire-tube boilers placed in two water-tight compartments. The engines are required to develop 4,800 H.P. under forced draft, with a corresponding speed of 17 knots.

OTHER NEW SHIPS.

The third of the 2,000-ton cruisers, the contract for which was let to Harrison Loring, of Boston, was launched August 11. Work on this ship has been delayed somewhat by financial difficulties of the contractor, which have now been arranged, and by delays in delivering steel. She is a sister ship to the *Detroit* and the *Montgomery*, built in Baltimore, and now nearly completed.

Plans are being prepared for the new armored cruiser authorized by Congress. While this ship will have a general resemblance to the *New York*, it is probable that her displacement will be somewhat greater, most of the additional weight going into additional armor and heavier armament. The plans proposed provide for a battery of eight 8-in. guns carried in four turrets and twelve 5-in. rapid-fire guns; the secondary battery to include twelve 6-pdr. rapid-fire and several machine guns. The *New York's* battery is to include only six 8-in. guns, twelve 4-in. rapid-fire guns and eight 6-pdr. cannon.

Plans are also in preparation for the new battle-ship authorized. She will be probably of somewhat larger displacement and greater speed than those now under construction. It is said also that the triple-screw arrangement used in Cruisers 12 and 13 may be applied; but no definite decision has been made as yet.

ARMOR TESTS.

The first test of armor-plates at the new proving ground of the Bethlehem Iron Company at Bethlehem, Pa., took place July 30. The plate tested was a 10½-in. Harveyized nickel-steel plate, 8 × 6 ft. in size, and weighed 18,600 lbs. In tempering the plate it was treated with the ice-water process, which rendered its surface exceedingly hard and brittle.

Five shots from an 8-in. rifled gun were fired at the plate; four in the corners, and the fifth in the center. The charges consisted of 81¾ lbs. of powder and a 250-lbs. Holtzer projectile. The velocity of the projectile was 1,700 ft. a second.

Each projectile pierced the plate about three inches, rebounded, and broke into bits the size of walnuts. Not a single crack was developed in the plate.

The test was witnessed by several officers of the Navy and was regarded as a very successful one.

A COMPOUND STATIONARY ENGINE.

THE accompanying illustration shows a stationary engine of the tandem compound type, which has been made for both heavy and light work. The special type is that manufactured by the Harrisburg Foundry & Machine Works, and to which they have given their name of the "Ideal" compound engine. In addition to the self-oiling feature, an arrangement which has been very successful in the simple engines built by the same Company, the compound has some additional points of interest. It is not a small simple engine compounded by adding a large low-pressure cylinder to it, nor are the high-pressure cylinder and connections hung on like an after-thought or makeshift, but it has been designed as a compound engine, and is a compact and serviceable machine. Special pains have been taken to make all the wearing parts accessible, and to make all bearings and wearing surfaces sufficient for the maximum power of the engine when condensing. In this engine it is not necessary to dismantle it to examine the low-pressure piston, but the intermediate connection is so constructed that the stuffing-boxes are accessible for adjustment or renewal of packing, and the low-pressure piston can be moved into the space between the cylinders for examination without breaking any other joints than the cylinder-heads.

In this engine, and all of the same class, the valves are worked by separate eccentrics. The high-pressure valve is controlled by the automatic governor, while the low-pressure eccentric is adjusted by hand for any desired cut-off in the large cylinder. The valve for the small cylinder is a solid piston-valve; in the large cylinder a patent adjustable valve is used, which is shown in fig. 2.

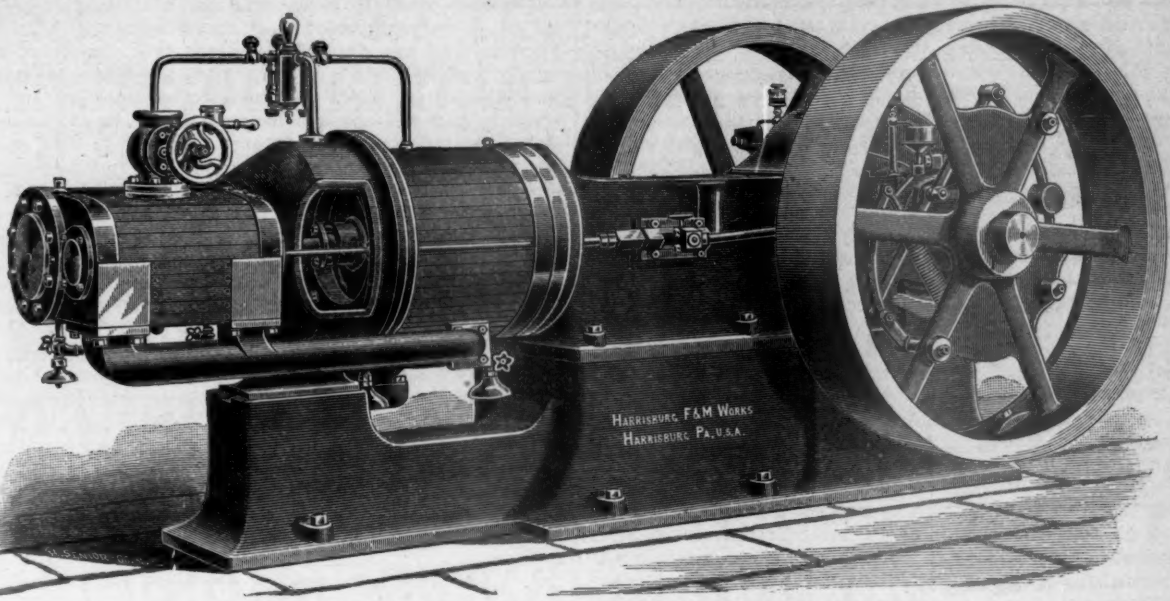
This patent adjustable valve was designed by M. E. Hershey, Manager of the Works, with the object of providing a piston-valve capable of rigid adjustment to compensate for wear, and a valve which will contract when the parts are cooled, preventing sticking or injury to wearing surfaces.

To accomplish this purpose an adjustable sectional spider is introduced, as shown in the cut, of composition metal or brass, having greater range of expansion than the metal in the valve proper or its seat. Live steam is admitted between the valve disks and the adjustment made when hot, the normal working condition. When steam is stopped off from the valve and the parts cool, the sectional brass spider contracts to a greater extent than the balance of the surrounding metals, and releases the packing rings, leaving them entirely free in their seats. When steam is admitted, the expansion of the spider being proportionately greater, the valves necessarily quickly assume their original adjustment.

It is the employment of the metals of varying expansibility that makes the positive valve adjustment practica-

ble. The brass spider, having the greater range of expansion, is so constructed as to be most susceptible to the change of temperature.

The general construction is shown in the cut; it will be observed that the peripheral adjustment to compensate

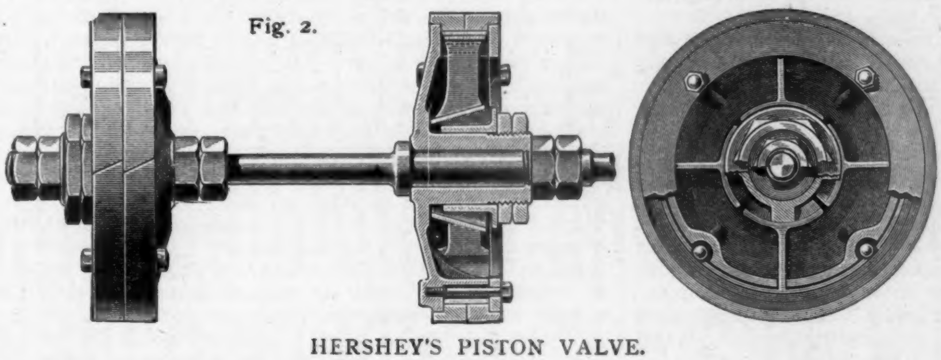


THE HARRISBURG IDEAL TANDEM COMPOUND ENGINE.

for wear does not affect any other adjustments for steam distribution.

The advantages claimed for this form of valve are that it is tight, balanced, and reduces the friction to a mini-

Fig. 2.



HERSHEY'S PISTON VALVE.

mum, while these conditions can be maintained to a greater degree than is possible with any other form of valve. The valve being light, the wear on the driving mechanism is reduced to a minimum and better regulation is attained with any form of governor, while, moreover, it can be adjusted without special mechanical skill or equipment. Experience has shown that with this valve the expense of maintenance is decreased.

LABOR LEADERS.

WE reprint herewith, from the New York *Evening Post*, part of a lecture by M. Julien Weiler, of Morlanwelz, Belgium, who is widely known and respected in industrial circles throughout Belgium, and is an acknowledged authority on the labor question. He is at the head of the engineering department of the two great mining companies of Mariemont and Bascoup, and has been the means of establishing for both companies (which together employ more than 6,000 men) Boards of Conciliation and Arbitration, on which the companies and the workingmen are equally represented.

Mr. Weiler's lecture (delivered in 10 different cities of Belgium during the past three months) is entitled, "Industrial Conciliation and the Rôle of the Labor Leader." After explaining in the first part of the lecture what he means by industrial conciliation, the lecturer, in the second part, speaks as follows:

There is no doubt that this theory of industrial conciliation, based entirely upon confidence in the intelligence and moderation of both parties, will seem strange to those who, upon the authority of certain writers, think of employers only as men of unscrupulous greed, governed solely by a shameless love of money. It will also surprise others who regard workingmen as beings of ungovernable ferocity, whose unreasonable demands can only be met by force. These people would be still more surprised could they associate familiarly with the men whom they judge only by exceptions, had they the opportunity to learn how much benevolence there is among employers, and what patience among workingmen, whose efforts, in fact, are all aimed only at securing their rights.

But this brings me to another objection to the plan which I have explained to you. What sort of delegates will the workingmen send to these Boards? Is it not to be feared, if the elections are untrammelled, that it will be just the worst men in the shops? Those discontented fellows, always at the head of every disturbance, who want anything except peace, and of whom, therefore, it would be folly to expect anything useful? Well, yes, I should have to say to any one who asked me such questions, You certainly would have as delegates the very men whom you object to meeting. There is not the slightest doubt on that point, for everywhere where the experiment has been made, the elections have brought face to face on the Boards of Conciliation and Arbitration the men from both sides who hated each other the most.

But why did they hate each other? Because, up to that time, they had only known each other by the fighting qualities which had placed them at the head of their respective parties—because it was perfectly natural that each side should send to the Board the men who had given them proofs of their devotion, and because, naturally also,

LOCOMOTIVE RETURNS FOR THE MONTH OF MAY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	54	42,696	77,615	39,505	159,816	3,326	....	....	57.31	83.68	37.38	66.22	....	...	5.10	4.20	0.25	0.40	6.20	1.90	18.05	....	...	....
Alabama & Vicksburg	....	15	12,193	14,912	10,083	37,188	2,473	....	....	50.00	91.32	39.92	62.35	....	....	4.70	5.90	0.29	1.00	6.30	1.70	19.79	....	....	....
Atchison, Topeka & Santa Fé	834	733	....	....	370,136	2,258,730	3,081	....	....	...	....	....	73.23	....	....	3.67	5.79	0.28	0.11	6.65	1.31	17.81	....	...	1.48
Canadian Pacific	595	...	495,079	766,427	411,100	1,672,606	2,811	...	....	....	....	...	61.60	....	...	3.63	11.03	0.40	....	5.33	1.32	21.71	....	1.87	3.54
Chic., Burlington & Quincy	518	...	....	....	....	1,744,585	3,368	4.98	17.75	....	....	....	83.02	....	....	5.09	5.71	0.29	0.22	6.48	....	17.79	...	...	1.35
Chic., Milwaukee & St. Paul	803	....	....	....	....	2,312,572	2,880	....	....	....	....	....	69.23	....	....	4.88	6.93	0.27	....	7.00	....	19.08	....	...	1.95
Chicago & Northwestern	862	....	683,951	1,318,538	798,031	2,800,520	3,249	....	....	....	....	....	79.08	....	....	3.36	7.04	0.36	....	6.32	0.86	17.94	....	...	1.76
Cincinnati Southern	....	103	81,921	174,422	86,215	342,558	3,326	...	...	60.79	110.49	43.76	82.64	....	....	4.30	5.20	0.27	0.50	6.50	1.60	18.37	....	....	...
Cleve., Cinn., Chic. & St. L.	....	426	423,151	559,690	264,905	1,349,746	3,168	4.60	21.50	94.70	102.25	68.82	87.07	15.61	6.91	3.12	5.52	0.2[illegible]	1.73	6.36	0.25	17.22	...	....	1.26
Cumberland & Penn	...	20	5,772	27,419	....	33,191	1,660	....	....	....	....	....	85.47	....	....	6.06	4.60	0.40	....	....	2.00	13.06	....	...	....
Delaware, Lackawanna & W. Main L.	207	197	....	....	....	692,749	3,516	....	....	...	....	....	80.61	....	....	3.06	6.60	0.40	....	5.83	....	15.89	....	...	....
Morris & Essex Division	154	....	166,350	248,321	12,981	427,652	2,777	....	....	....	....	....	59.75	....	....	4.31	9.42	0.36	...	6.19	....	20.28	....	....	...
Hannibal & St. Joseph	41	36	42,518	78,079	27,421	148,003	3,610	5.08	16.54	...	....	....	80.71	14.59	6.19	6.91	4.70	0.17	0.24	6.24	....	18.26	....	....	1.28
Kan. City, F. S. & Mem.	143	...	102,232	209,921	109,014	421,167	2,945	....	....	....	....	....	60.09	....	...	3.85	5.01	0.20	0.46	7.35	....	16.87	....	....	1.62
Kan. City, Mem. & Birm.	38	....	35,985	48,624	17,853	102,462	2,499	....	....	....	...	....	52.07	....	....	2.97	3.06	0.24	0.42	7.05	....	13.74	....	....	1.12
Kan. City, St. Jo. & Council Bluffs	43	41	59,512	44,714	44,824	149,050	3,485	4.61	22.68	...	....	....	59.24	12.41	4.12	3.63	4.28	0.10	0.09	5.31	....	13.41	....	....	1.78
Lake Shore & Mich. Southern	590	....	425,147	705,059	585,054	1,715,260	2,907	....	....	58.22	84.50	32.49	60.90	....	....	3.32	4.83	0.17	....	6.91	0.21	15.44	....	....	1.58
Louisville & Nashville	....	*338	437,280	788,090	398,232	1,623,592	3,625	5.13	15.99	62.21	106.12	45.81	78.66	12.14	6.41	4.51	6.52	0.27	0.41	6.07	1.61	19.39	3.14	1.51	1.66
Manhattan Elevated	....	289	782,332	10,128	54,868	847,328	2,932	..	....	....	....	....	41.75	....	....	2.40	8.30	0.30	....	8.70	..	19.70	....	..	3.94
Mexican Central†	146	115	....	....	....	377,863	3,286	....	...	...	....	....	60.33	....	....	5.83	14.09	0.45	0.13	5.64	0.96	27.10	....	....	5.18
Mil., L. S. & Western	112	101	76,840	156,362	110,585	343,787	3,404	....	....	....	....	....	72.26	....	....	3.08	10.80	0.24	....	6.14	0.93	21.19	....	....	3.00
Minn., St. P. & Sault Ste. Marie	....	....	65,399	119,484	38,851	223,734	.....	4.89	16.44	...	....	....	55.10	....	....	3.95	9.15	0.20	....	6.30	....	19.60	....	1.84	4.07
Missouri Pacific	339	302	....	....	....	1,067,787	3,541	4.36	16.16	....	....	....	79.33	18.11	5.65	5.32	5.66	0.22	1.37	6.50	1.61	20.68	4.61	1.45	1.39
N. O. & Northeastern	...	28	29,976	43,052	21,482	94,510	3,375	....	....	60.79	106.38	34.81	76.63	....	....	6.80	7.30	0.28	0.60	6.20	1.70	22.88	....	....	....
N. Y., Chicago & St. Louis	138	136	39,673	356,079	142,753	538,325	3,958	3.70	24.10	...	....	....	86.96	13.62	4.65	3.00	7.20	....	0.30	6.50	...	17.00	4.60	0.70	....
N. Y., Lake Erie & Western	....	625	446,375	1,000,207	292,009	1,738,591	2,782	4.60	23.10	84.60	130.70	66.60	....	18.30	5.70	4.98	6.92	0.39	2.25	7.10	1.06	22.70	...	1 57	1.28
N. Y., Pennsylvania & Ohio	....	262	139,241	418,178	137,744	695,163	2,653	5.50	18.10	68.90	121.50	70.50	....	12.50	6.70	4.08	5.87	0.31	1.95	6.71	1.01	19 93	....	1.66	1.15
N. Y., Prov. & Boston	....	92	108,993	52,320	57,116	218,429	2,374	....	...	....	...	....	50.01	....	....	3.40	9.63	0.53	....	6.41	1.26	21.23	....	...	....
Norfolk & Western, Gen. Eastern Div.‡	....	138	98,293	221,743	66,387	386,349	2,883	4.50	19.70	...	....	....	96.62	....	....	6.60	4.00	0.70	....	....	....	11.30	....	....	....
Durham Division‡	....	6	7,410	11,058	4,099	22,567	3,761	5.00	3.20	...	....	....	48.08	...	...	2.30	6.70	0.40	....	....	....	9.40	....	....	....
Radford Division‡	....	45	16,911	104,573	65,200	131,684	2,926	5.20	17.90	....	....	....	125.80	....	...	8.60	5.10	0.70	....	....	....	14.40	...	....	....
Pulaski Division‡	....	28	27,180	41,929	7,520	76,629	2,780	4.90	14.30	....	....	....	96.15	....	....	5.10	3.90	0.90	...	...	....	9 90	...	....	....
Clinch Valley Division‡	....	35	21,070	47,962	16,701	85,733	2,449	3.70	11.20	....	....	....	125.80	....	....	8.80	5.00	0.90	....	....	....	14.70	....	....	...
Winston-Salem Division‡	....	10	12,805	8,860	3,389	25,054	2,505	2.20	10.50	....	....	....	80.00	....	....	3.90	8.00	0.80	....	....	....	12.70	....	....	....
Old Colony	220	....	315,720	140,536	121,710	577,966	2,627	..	....	....	....	....	55.10	....	....	3.51	10.33	0.63	....	6.76	0.78	22.01	.. .	....	3.75
Ohio and Mississippi	112	....	134,434	147,976	88,882	371,292	3,315	....	....	....	.. .	....	70.18	....	. ..	3.42	3.07	0.24	1.07	5.46	1.47	14.73	...	...	0.83
Philadelphia & Reading	....	....	455,967	712,447	514,538	1,682,952	....	....	....	....	....	....	82.88	....	....	4.77	4.61	0.31	....	5.81	0.42	15.92	....	....	....
South. Pacific, Pacific System	701	....	....	....	....	1,688,482	2,409	....	....	...	....	.. .	67.68	....	....	5.19	18.76	0.25	2.27	7.30	1.19	34.96	....	....	5.70
Union Pacific	995	...	689,085	1,162,287	477,559	2,328,931	2,341	5.73	16.22	..	....	....	98.28	14.92	8.10	6.99	9.84	0.43	0.94	8.03	1.18	27.41	4.52	2.10	2.00
Vicksburg, S. & P.	....	13	10,502	10,202	10,341	31,045	2,388	....	....	46.08	71.43	23.34	49.02	....	....	3.20	6.70	0.27	0.90	6.50	2.60	20.17	....	....	....
Wabash	402	333	410,275	619,787	227,844	1,257,906	3,778	4.98	16.01	66.05	98.33	53.71	79.66	13.33	6.19	3.20	4.55	0.28	....	6.23	0.91	15.17	2.59	1.11	1.14
Wisconsin Central	152	125	130,217	212,624	72,278	413,119	3,305	....	....	....	..	....	75.73	....	....	3 09	9.18	0.24	....	7.21	....	19.72	....	...	2.36

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only ; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 17.9 units of work per $1 of expense ; 181.3 units of work per ton of coal ; 11.03 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

the leaders of hostile armies cannot have much affection for each other. We ourselves (I am speaking of the mining companies of Mariemont and Bascoup) had the disagreeable experience of receiving as delegates to the Board all those leaders whom we had only known by the very unflattering description we had heard of them, or by the exorbitant demands which had been reported to us as made by them. But, strangely enough, we had scarcely entered into relations with these men than we had to correct our impressions of them, for these terrible fellows turned out to be—not saints, of course—but men of intelligence and of the best intentions—men, that is, excellently fitted for the important duties required of them. The fact was that all their good qualities had been entirely hidden from us, while we had been looking at their faults under the microscope.

Having entered on this interesting subject, will you allow me a few moments to speak of the labor leader as I view him? I insist upon it that there are leaders and leaders, and I divide them into two classes, placing in the first the leaders belonging to the trade they represent, and in the second those who have no connection with the trade whose interests they undertake to defend. The leaders of the first class, those belonging to the craft they represent, I call *good leaders*. We shall see later whether the others can be called *bad*, and if so, to what degree? *Good leaders*, I say, and I call them so because they possess all the qualities which an employer can ask for in these indispensable mediators between himself and his employés.

An intelligent employer, instead of making their task more difficult, ought to do all in his power to help these leaders. To help the leaders? So far from that, a man has usually only to be the spokesman for his fellows in some request to their employer, in order to be accused of fomenting trouble in the shop and to be put on the black list.

I know of very few strikes which have not been followed by the discharge of the men forming the committees which led them, and even when these discharges do not take place at once and publicly, they take place just the same! Visit any shop or mine a few months after work has been resumed, and you will find but few of the leaders of the strike still at work. And then it is considered extremely ridiculous that the men, deprived of their natural leaders, turn to others, strangers to their craft, and of course less capable of leading them, but who, at least, are not in the power of their employers.

"Do you know," said one of the directors of a mine to me one day, shaking his head and shrugging his shoulders—"do you know what leaders my men have got now? A weaver from Verviers, a printer from Brussels, and a shoemaker from Charleroi! And," he added, "you want me to talk business with them!"

"Well," said I; "what have you done with the *miners* who led your last strike?" And I am still awaiting his answer. And these leaders are treated in this way, notwithstanding the fact (I am speaking of the leaders chosen by the workingmen from their own trade, not of the others) that they are usually the most intelligent, the most skilled, and the most courageous men to be found in the trade. Courageous, did I say? The word is not strong enough. They must have, besides courage, a spirit of self-sacrifice, or else mere foolhardiness, to dare to face the employers, after the many warnings they have had of the danger to themselves of such action.

But what are the qualities of a *good leader?* First, a complete knowledge of his craft, and consequently a perfect understanding of the conditions of the trade and its needs. Second, that he should have a personal stake in the trade, supplied by the fact that every change suggested by him will affect his own welfare and that of his family. The good leader is always a good workman, and often of exceptional skill; outsiders, coming from a distance, may influence the mass of workmen by other qualities, and succeed among them even if they know nothing of the trade, but he to whom the saying "A prophet is not without honor save in his own country," is especially applicable, cannot be chosen leader unless he gives proofs of his superior skill as a workman.

And these are the men whom employers, most unfortunately, make it a rule to discharge as soon as the respect of their fellow-workmen makes them prominent! And with what result? Simply to bring forward the *bad leaders!* The employers will not accept the leaders whose every circumstance is a guarantee of good faith and moderation, and they must therefore deal with those who offer no guarantee, for it is utterly impossible (as is proved by history) to effectually resist the force which is driving the workingmen toward their emancipation, and consequently to the use of all the means necessary to attain it.

And who are these other leaders, whom I will call *independent*, to distinguish them from the first? They are either men of education, but without experience in trade matters, and therefore unable to solve the problems to which they usually devote enthusiasm and talents which deserve a greater measure of success than they attain, or they belong to the class who have lost their natural place in life, such as are produced in all times of excitement.

I shall say nothing of the first, except to regret that our industrial customs, in putting them in the place of the natural leaders of the workingmen, divert them from other work which might be useful, and to declare emphatically that, although I condemn the sophistries by which they seek to lead astray the people of our towns, yet I believe their motives to be pure even if not unmixed with ambition.

But what of the leaders whom we may truly call *bad*, who fish in troubled waters, birds of ill-omen who fly to the scene of hostilities as soon as an industrial conflict is threatened? It would be difficult to feel toward them as kindly as toward the others, but is it not true that they would not exist if those whose places they take (the good leaders) had been treated differently? To begin with, where do they come from? I can tell you, at least as regards many of them. They come from the shops and the foundries and the mines from which they have been systematically driven whenever they have tried to act the part of good leaders—they are like cats whom fear has transformed into tigers—or rather like dogs, whom a merciless boycott has driven mad!

But if we ask how we can best make head against the cruel dynamiter, whether of hand or of tongue only, who in our day has attained to so sad a celebrity, I can only refer you to what I heard said by the Mayor of Ghent, that, if that important city had been saved from anarchy, it was due to the growth of a great labor organization.

I hope I have shown you that it is impossible to alienate the natural intermediaries between employers and employed, the natural leaders in all labor movements, without seeing their functions usurped by agitators, whose least defect it is that they furnish no guarantee of either intelligence or responsibility. There *must* be labor leaders! That is one of the conclusions of this lecture, and I hope that you consider that it is proved by the arguments I have presented to you.

COLUMBIAN EXPOSITION NOTES.

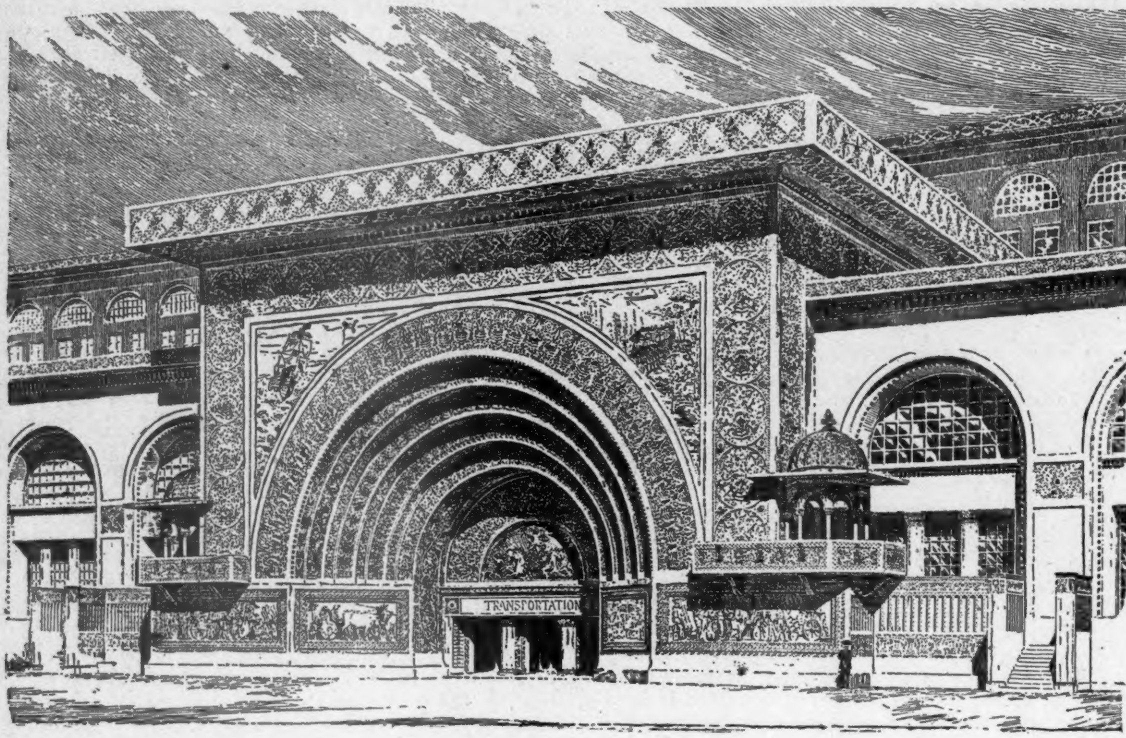
The time officially set for receiving applications for space at the Exposition expired August 1. It is understood that requests for space can still be received, but late applicants will have to take their chances for admission, and cannot expect favorable positions.

A very curious exhibit will be made in the Transportation Department by the firm of Cook & Son, of London. It is intended to illustrate methods of traveling outside those ordinarily in use in civilized countries, and will include such means of transportation as the Norwegian carriole, Norwegian sleigh, Lapland dog sleigh, Irish car, Neapolitan cart, Turkish caique, Palestine encampment, camel saddle and harness, elephant with howdah, Bombay bullock cart, catamaran, Chinese palanquin, Japanese jinriksha, models of the dahabeahs or boats used on the Nile, and the like.

The Chief of the Transportation Department, Mr. Willard A. Smith, has secured for exhibition one of the

boats used by the Canadian voyageurs, which he found in the State Historical Museum of Wisconsin, at Madison. The boat is an old batteau of the pattern used by the French-Canadian fur traders in their voyages on the lakes and rivers of the Northwest before Illinois or Wisconsin had been organized as territories. It is a leviathan of canoes, weighing 1,100 lbs., is 30 ft. long, and in its day carried 18 men and over a ton of goods for the Indian trade. Secretary Thwaite of the Wisconsin Historical Museum, on one of his canoe trips two years ago, found this relic, water-logged, on the banks of the Upper St. Croix, and had it conveyed to Madison.

THE Hoboken Land & Improvement Company will exhibit a fac-simile of the twin-screw steamer built in Hoboken by Mr. Stevens, in 1805. It will have the original boiler and engine, which have been preserved as relics. In connection with this the company will show a model of the *Hamburg*, the latest double-screw boat built for the ferry between Hoboken and New York.



THE "GOLDEN DOOR" OF THE TRANSPORTATION BUILDING, COLUMBIAN EXPOSITION.

THE accompanying illustration shows the most striking architectural feature of the Transportation Building — the "Golden Door." It will serve to give, even without the beautiful coloring which will characterize it in its completed state, a very good idea of what promises to be one of the most notable architectural features of this display. The dimensions of this door, as well as those of the building itself, have been so frequently published that it is useless to again reproduce them, but the accompanying sketch gives some idea of the general design and proportions.

IT is stated that the exhibit of the New York Central & Hudson River Railroad Company will include a reproduction of the first passenger train run on the old Mohawk & Hudson Railroad—the first beginning of the Central—which will be placed beside a complete train of vestibuled cars of the latest pattern.

Foreign Naval Notes.

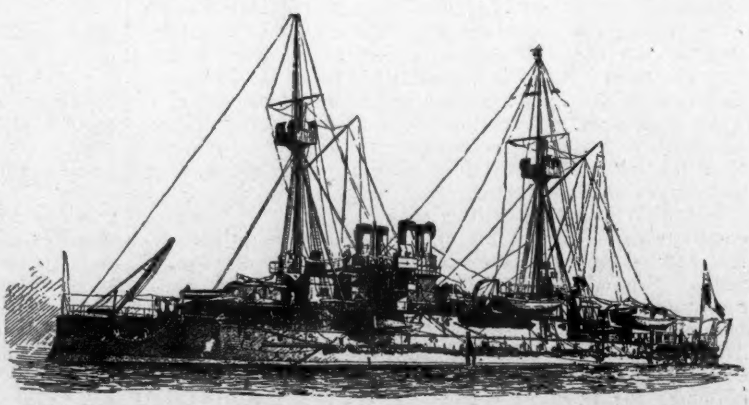
A FRENCH COAST-DEFENSE SHIP.

THE cut given below, from *Le Yacht*, shows the armored coast-defense ship *Terrible* of the French Navy. This vessel is a heavily armored ship 280 ft. long, 59 ft. beam and 7,713 tons displacement; she carries two very heavy guns 42 cm. (16.5 in.) caliber; four 3.9-in. rapid-fire guns; two 1.85-in. rapid-fire guns and 16 revolving cannon and machine guns.

The illustration shows another instance of the tendency of the French designers to pile up structures upon the decks of their armored ships, which gives them a somewhat clumsy appearance.

Lake Monitors.

THE first of the monitor type of cargo vessel, the *Andaste*, which has just taken 2,300 gross tons of iron ore from Escanaba on a draft of 14 ft. 10 in. forward and 15 ft. 2 in. aft, can be pronounced a successful carrier. On this draft—15 ft. even—

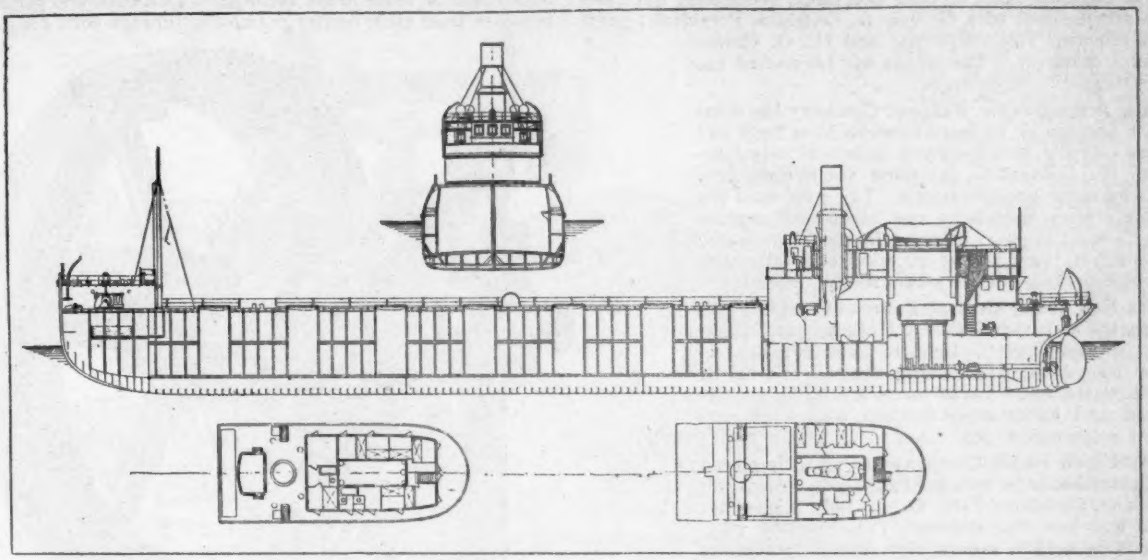


HARBOR DEFENSE SHIP "TERRIBLE," FRENCH NAVY.

the *Andaste's* cargo is full 150 tons greater than cargoes carried on the same draft by the *Wawatam* and *Griffin*, boats in the same fleet that are of similar dimensions but of the ordinary

type of steel steamers. President Henry D. Coffinberry, of the Cleveland Ship Building Company, builders of the monitors, made the trip to Escanaba on the *Andaste*, and is very much pleased with the boat.

The accompanying illustration, made from drawings prepared just before the boat was launched, shows the monitor after several important changes in the original design. The second boat of this type, the *Choctaw*, is about ready for launching at the yard of the Cleveland Ship Building Company. The boat's dimensions are 266 ft. keel, 38 ft. beam and 23 ft. hold. The triple-expansion engines are 17, 29 and 47 in. × 36 in. stroke, getting steam from two 11 × 12-ft. boilers and turning an $11\frac{1}{2}$-ft. wheel. The water bottom is $4\frac{1}{2}$ ft. deep and is emptied and filled by a ballast pump with a 14-in. steam cylinder, 18-in. water cylinder and 12 in. stroke. The steam-steering gear can be worked by two wheels, one on the windlass house deck and the other from the pilot house aft.—*Cleveland Marine Review.*



THE LAKE CARGO STEAMER "ANDASTE."

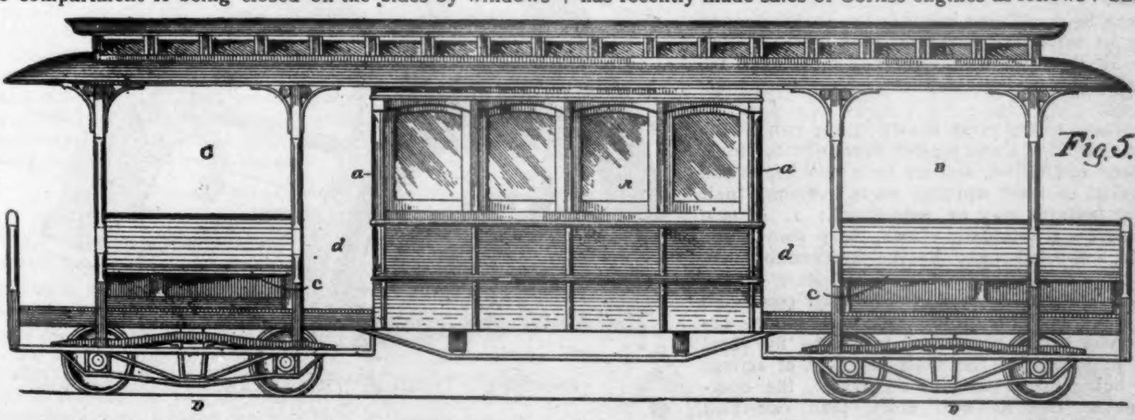
Recent Patents.

CABLE RAILROAD CAR.

Mr. John Hammond, of San Francisco, Cal., has patented the form of cable car shown in fig. 5, which he describes as follows:

The car is built with three compartments, *A*, *B* and *C*, the middle compartment *A* being closed on the sides by windows in the usual manner, and having a sliding door at each end, and a seat running lengthwise on each side of the car. The end compartments *B* and *C* are of open construction, being without windows or doors, and are provided with seats *c c*, running lengthwise of the car, as shown, and are placed back to back, with a sufficient space between the backs for working the cable-gripping mechanism. The entrances to compartment *A* are open at all times to the street by passages *d d d d*.

The symmetrical construction of this car adapts it for running in either direction, and greatly facilitates the handling at the terminus of the roadway, as the car is not turned around at this place; but by making a simple change in the gripping mechanism it is ready to commence the return trip. The open construction of the end compartments allows the gripman to have an unobstructed view ahead and on the sides. It will thus be seen that this car will run in either direction with equal facility. The appearance and construction of the car is the same at each end, being in fact a double combination-car.



HAMMOND'S CABLE RAILROAD CAR.

Manufactures.

General Notes.

The Jewett Supply Company will have early in September 60 passenger cars fitted with its anti-friction device on the Boston & Albany Railroad; this is a result of the excellent working of those already in use. The orders lately received are for the equipment of two full trains on the New York & Boston through line and the directors' car. Orders have also been received to equip some passenger cars for the Baltimore & Ohio and some cars for the Union Tank Line. The Boston & Albany intends to equip all its cars as fast as possible.

The Weisel & Victor Manufacturing Company, Milwaukee, has recently made sales of Corliss engines as follows: Sheboygan, Wis., Electric Company, one 46 × 48 in.; Mattoon Manufacturing Company, Sheboygan, Wis., one 46 × 42 in.; Cudahey Brothers, Milwaukee, one 20 × 42 in., one 22 × 42 in. and two 24 × 48 in.; Republican House, Milwaukee, one 14 × 36 in.; Opaque Cloth Company, Chicago, one 20 × 42 in.; Demme & Dierkes Furniture Company, Kankakee, Ill., one 26 × 48 in.; Heroy & Marrenner, Chicago Heights, one 10 × 30 in.; Milwaukee Malt & Grain Company, one 20 × 42 in.; Lembeck & Betz, Jersey City, N. J., one 22 × 42 in.; Swift & Company,

Chicago, one 18 × 42 in. high-pressure and one cross-compound, non-condensing, 24 and 34 × 48 in.; Chicago, Milwaukee & St. Paul Railroad Company, Milwaukee, one 500-H.P. cross-compound, condensing; Badger Illuminating Company, Milwaukee, one 600-H.P. cross-compound engine.

THE Irondale Steel & Iron Company, Anderson, Ind., has been reorganized, with George A. Laughlin, President; John T. Whitelaw, Vice-President, and H. O. Crane, General Manager. The works will be started up, and will shortly be enlarged.

THE Pennsylvania Railroad Company has completed and put on its ferry between New York and Jersey City the *Washington*, a new boat very similar to the *Cincinnati*, described some time ago, but with some improvements. The new boat has double screws, driven by two compound engines with Canfield's valve, as used in the *Cincinnati*; she is 206 ft. long, and 65 ft. wide over all. She is double-decked and very handsomely fitted up.

THE New Jersey Central Railroad Company has contracted with the Harlan & Hollingsworth Company, of Wilmington, Del., to build two double-screw ferry-boats 154 ft. long over all and 148 ft. on the water-line. These boats are to be double-decked and handsomely finished, with large passenger accommodations.

THE Union Pacific Company has recently placed a considerable order with the Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., for hollow stay-bolt iron; and has also specified Falls Hollow stay-bolts to be used in several new locomotive boilers ordered from outside shops.

THE Pennell water purifier is to be put in at the water station at Bitter Creek on the Union Pacific. The water at that point is exceptionally bad, containing a very large proportion of alkali and various salts, and the company has had much trouble with the boilers on that division of the road.

HENRY C. GOULD has been chosen Vice-President and General Manager of the Gould Coupler Company, and F. P. HUNTLEY has been chosen Secretary of the Company.

An Embosssing Power Press.

THE illustration given herewith shows a power press used for embossing small work of various kinds, formerly done in drop presses, and which is adapted to a considerable range of work. This press, which is numbered 33 by the makers—the Ferracute Machine Company, of Bridgeton, N. J.—is the third in a series of four sizes used for this purpose.

It may be mentioned incidentally, as showing the extent of the press business, that the new catalogues of the Ferracute Company show over 150 sizes and kinds of presses for general sheet-metal work.

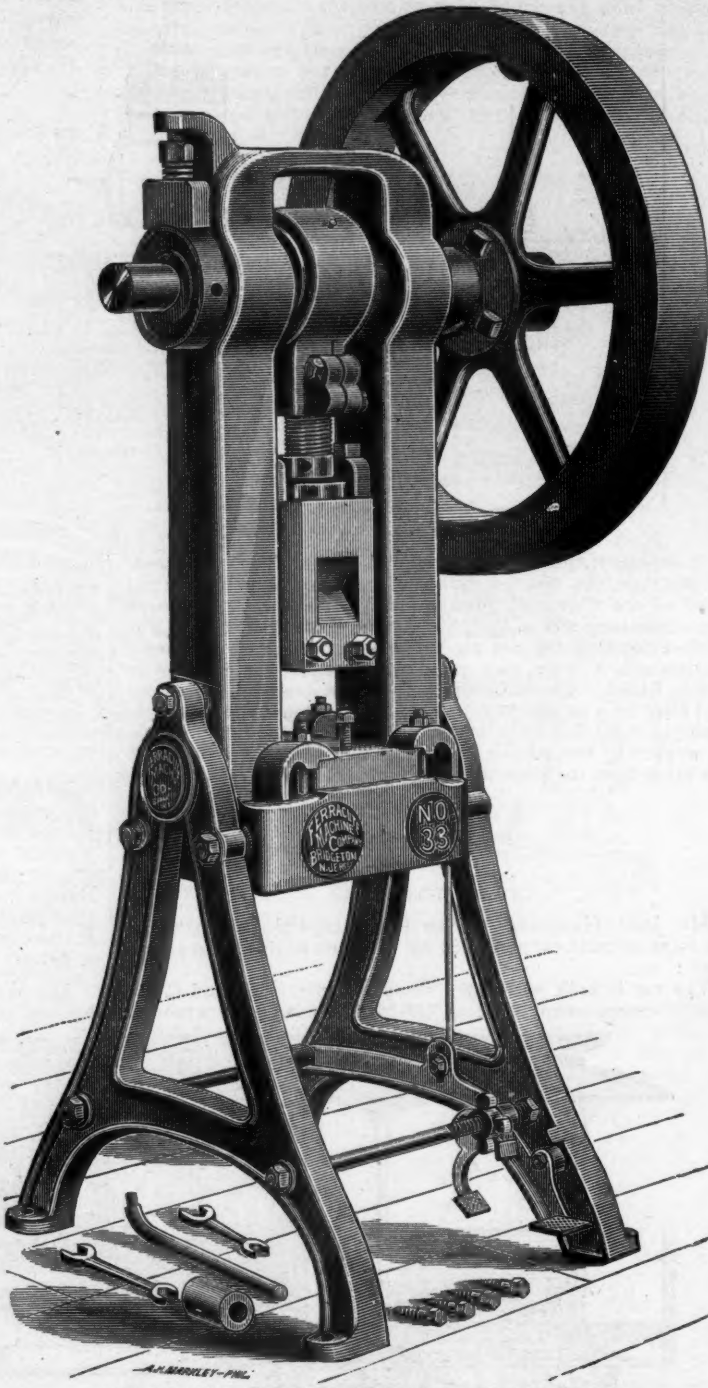
Returning to the press shown in the cut, it may be said that all of these presses have solid columns, not cored out hollow, and are built very heavy and substantial in their working parts. Among their peculiar features may be mentioned: 1. A new and improved automatic clutch, very simple and durable, and so arranged that the shaft cannot make more than one revolution by one action of the treadle. It consists of a lever or button connected with a sliding-pin in the shaft. This pin engages with studs projecting from the fly-wheel which runs loose on the shaft when out of action. There being three studs in the wheel, the operator never has to wait more than one-third of a revolution for the press to start. The wheel pins have square heads and can be revolved as they wear, thus giving greater life to the clutch than in other forms, and when worn out they are very cheaply replaced. This clutch is provided also with a safety-pin to lock it, allowing the shaft to be revolved to any position, and the dies adjusted while the fly-wheel is in motion, thus dispensing with the need of a counter-shaft.

2. A reversible treadle-lock operated by the foot, by which the treadle can be fastened down for continuous running, or up for safety when the press is temporarily stopped.

3. A treadle bumper and stop of India rubber for securing a noiseless and limited motion.

4. An adjustable spring-brake which controls the motion of the press and adapts it to various speeds.

5. An adjustable ball-and-socket pitman, provided with an improved clamping device at the upper end, thus avoiding the annoyance of loose joints incident to lock nuts, and giving the pressure from shaft to dies practically through solid metal.

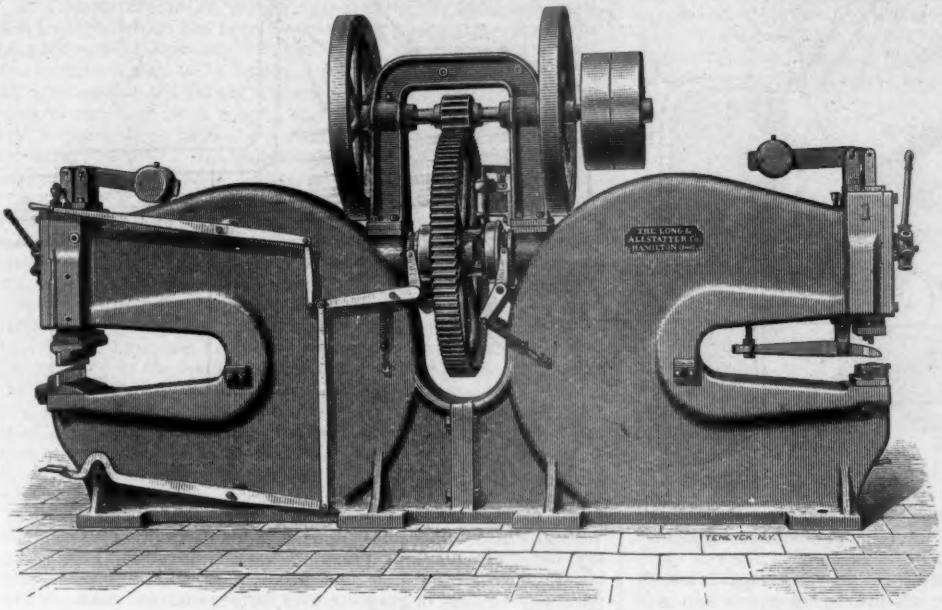


EMBOSSING PRESS BY THE FERRACUTE COMPANY.

The press is furnished with four die-clamps, the heads of the clamp-bolts sliding in slots in the bed. For some kinds of work two hook-headed clamps sliding in true bored holes are preferred, and these are furnished when ordered. The weight of press No. 33 is about 3,000 lbs.; weight of fly-wheel about 750 lbs.; diameter of fly-wheel, 39 in.; width of fly-wheel, 6 in.; stroke of slide-bar (variable to order), $1\frac{1}{2}$ in.; adjustment of slide-bar, 3 in.; size of each column, solid iron, $4\frac{1}{2} \times 7$ in.; breaking strain of columns about 2,500,000 lbs. The smallest size of this series weighs 1,000 lbs. and the largest 5,500 lbs. complete.

A Heavy Punching and Shearing Machine.

THE accompanying illustration shows a machine designed for general punching and shearing of iron and steel plate and for boiler work, which is made by the Long & Allstatter Company, of Hamilton, O. The machine is double, and both sides



HEAVY PUNCHING AND SHEARING MACHINE.

may be employed in punching or shearing, according to the tool with which it is fitted. The general advantage of the double machine, however, is that one side may always be ready for punching and the other side for shearing. Each side is entirely independent, and may be operated while the opposite side is at rest.

The machine is driven by a belt through powerful gearing turning steel cam shafts, and the latter may be turned by hand-gearing at the front of the machine to facilitate setting the tools. Where it is preferred to make the machine independent of a belt, it is provided with a double-acting steam-engine attached directly to it and designed for this special purpose. The slides are counterbalanced and the jaws are provided with convenient devices for the reception of the tools, punches, shearing belts, etc. The stripper is of convenient form and can be quickly removed.

The machine shown will punch holes up to 1½ in. through 1-in. plates as far as 48 in. from the edge of the plate. It will also shear 1-in. plates. This machine is made with throats of equal depth, but where it is preferred they are made with unequal throats.

The machine illustrated is a type of a large number of similar class which are made by the same Company for special operations in punching and shearing, and which are adapted for work of different classes, while their general design and construction is the same as the one shown.

Lake Shipbuilding.

THE F. W. Wheeler yard at West Bay City, Mich., recently launched the *C. F. Bielman*, a sister ship to the *Uganda*, which was lately illustrated in the JOURNAL. This yard has lately closed contracts for a steel steamer for D. C. Whitney, of Detroit, to be a duplicate of the *W. H. Gilbert*, described below; also for two very large steel steamers for Hawgood & Avery, of Cleveland, to be 360 ft. keel, 377 ft. 6 in. over all, 45 ft. beam and 25 ft. molded depth. They will have a 54-in. water bottom and carry 1,350 tons of water ballast. The engines will be triple-expansion, cylinders 23 in., 37 in. and 62 in. × 44 in. The boilers will be of the Scotch type, 12 × 12½ ft. The engines will be built in the Wheeler shops. Another contract is for a wooden schooner, 250 ft. keel, 41 ft. beam and 17 ft. molded depth.

The Globe Iron Works, Cleveland, have lately completed a large boat for the Minnesota Iron Company; she is 350 ft. long over all, 330 ft. keel, 45 ft. beam and 24 ft. 6 in. deep; the engines are triple-expansion, 24 in., 39 in. and 63 in. × 58 in., and there are three boilers.

Other large ships lately built are noted as follows:

Straightback, building by Detroit Dry Dock Company for Eddy Brothers, Saginaw: 360 ft. over all, 42 ft. beam and 24 ft. deep; engines same size as those of steamer *E. C. Pope*, which are 22, 35 and 56 × 44 in.

Pathfinder, building by the American Steel Barge Company, West Superior, Wis., for Samuel Mather, Cleveland, O.: 340 ft. over all, 325 ft. keel, 42 ft. beam and 25 ft. deep; engines 23, 37 and 62 in. × 42 in.; three boilers.

Monitor, building by the Cleveland Ship Building Company on their own account: 340 ft. over all, 324 ft. keel, 42 ft. beam and 24 ft. deep; engines 20, 33 and 54 in. × 40 in. stroke.

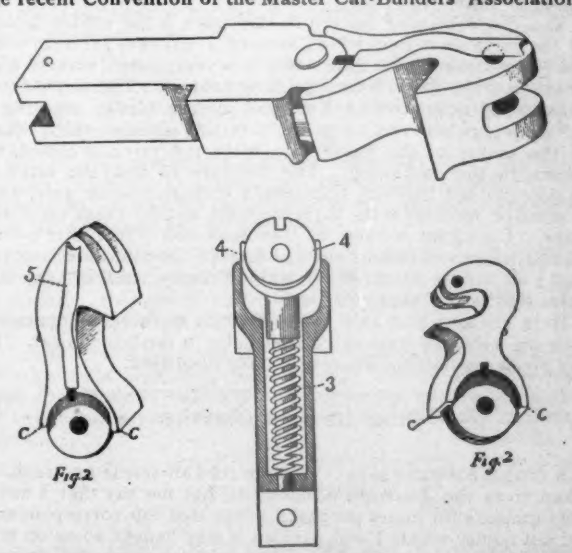
F. W. Wheeler & Company have lately completed the *Wapiti*, a very handsomely fitted yacht, rebuilt by Sibley & Bearinger. She is 83 ft. 6 in. keel, 86 ft. over all, 14 ft. 3 in. beam and 6 ft. 6 in. deep. She has a complete electric-light plant and all possible appliances for comfort. This yacht will be propelled by a compound engine 9½ and 21 in. with a 12 in. stroke, while the steam will be furnished by a patent Roberts safety water-tube boiler 7 ft. 6 in. × 8 ft.; working pressure, 200 lbs. It is thought that the boat will develop a speed of about 14 or 15 miles per hour. She has been rebuilt on the designs of Mr. A. K. Moseley, Draftsman of the company.

The Detroit Dry Dock Company has closed contracts to build a large steel freighter for the Western Transit Company and two steel passenger boats, to be the handsomest on the lakes, for the Detroit & Cleveland Steam Navigation Company.

The first of the three lightships built for the Lighthouse Board at the Wheeler yard has reached salt water safely, and the other two are on their way.

The Deitz Draw-Bar.

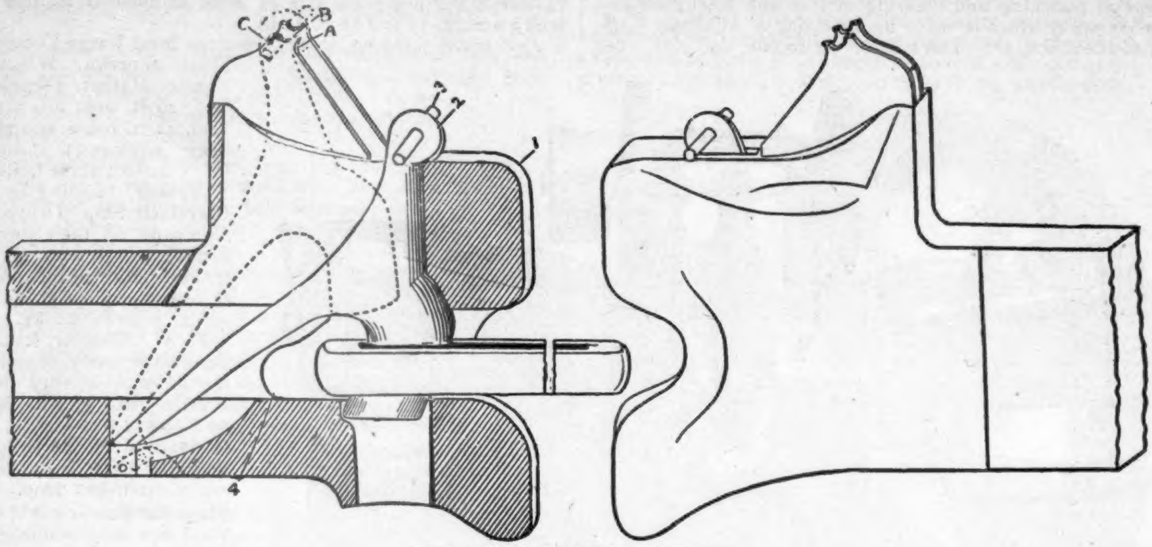
THE accompanying illustrations show a draw-bar invented by Mr. Henry Deitz, of Denver, Col., which was exhibited at the recent Convention of the Master Car-Builders' Association.



THE DEITZ PASSENGER DRAW-BAR.

The first illustration, figs. 1 and 2, shows Mr. Deitz's passenger draw-bar, which is intended to use a head of either the Miller or the M. C. B. type. The change can be made, as will be

seen from the drawings, by simply taking the pin out and substituting a new hook for the one previously in use and then replacing the pin, so that the change can be quickly made from



THE DEITZ FREIGHT COUPLER.

one form of head to the other. The advantages claimed are that cars in this way can be interchanged without difficulty where a different type of drawhead is used.

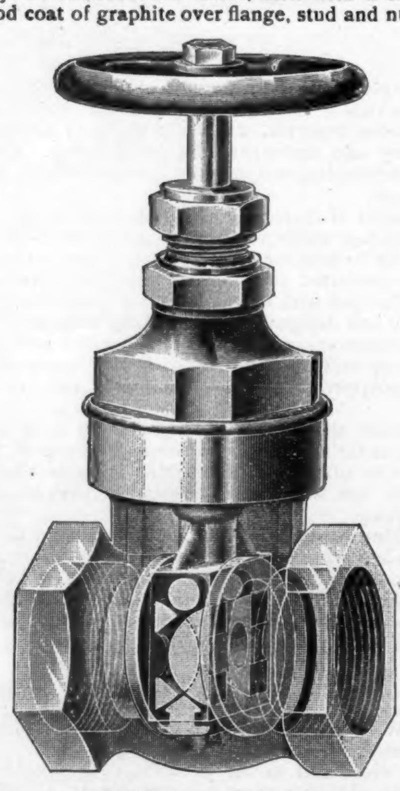
The freight coupler, which is shown in fig. 3, is a link-and-pin coupler, which, the inventor claims, is automatic and will not cause any difficulty in coupling on sharp curves. The key-hook is so shaped that if the link is pushed in while the hook is at its normal position it rises automatically and drops back into position, locking the coupler, while if the link has been previously inserted it can be dropped out or be lost. The drawing shows the arrangement sufficiently well, 1 being the draw-bar, 2 the key-hook, 3 hand-rod for uncoupling, and 4 the link-holder, while *A* shows the step, *B* the chair, and *C* the back of the chair. This can readily be worked from the side of the car by means of a rod and lever with a handle on the end. This coupler, we are informed, is to be tried on several roads.

A New Gate Valve.

THE illustration given herewith shows a new pattern of gate valve, to which the manufacturers have given the name of the "mobile wedge" valve; it is made by the Ross Valve Company, of Troy, N. Y.

The distinguishing feature in this valve is the rolling action of the movable wedge, which secures a uniform pressure over the entire back of the gate; this is accomplished without any grinding of the valve faces by sliding contact. The mechanism consists of two pairs of X-shaped bearing blocks carrying a rolling wedge between them, and a seating plunger which bears in the center of the valve case when the valve is closed, as shown in the engraving. The pressure to seat the valve is equally divided between four points on each disk or gate, and a positive motion seats them without sliding them on their faces. Each gate is hung on trunnions and is free to revolve, so that it is seated in a different place each time the gate is operated; an arrangement which will evidently tend to keep the valve tight and prolong its life.

It is claimed that this valve is much more easily operated than the ordinary gate valve, especially in the larger sizes. It has given satisfaction wherever it has been used.



THE ROSS GATE VALVE.

Other Uses for Graphite.

A CORRESPONDENT says: "I have read an article on graphite taken from the *American Machinist*. Let me say that I have used graphite for many purposes, some that the correspondent did not name, which I will give as it may benefit some of my brother engineers, who perhaps have not experimented to any great extent with the article. I have used handhole and manhole gaskets eight to ten times by carefully smearing the surface next boiler shell, taken out at periods of three to four weeks, using steam pressure as high as 100 lbs. In packing water glasses, by putting a little graphite and oil on the gasket they would vulcanize as soft as lamp-wick and retain their elasticity until the glass was changed, when the old rubber could be removed without trouble, while by the old way, I have spent much time in digging out the rubber, baked hard as vulcanite. Another thing I used it for was after putting back my handhole plate or plugs in back connection, I carefully brush away all the soot and ashes, then with a small brush paint a good coat of graphite over flange, stud and nuts. After running boiler from three to six months, and using coke for fuel, with forced draft, the nuts can be removed without trouble, as the heat has not been great enough to burn the lead."

Baltimore Notes.

MESSRS. JAMES E. HEWES & WILLIAM BROWNE, JR., Electric Engineers, have submitted a proposition to the Mayor and City Council to light the city by electricity. The proposition contemplates the utilization of the large overflow of Lock Raven Dam. The capacity of the plant is given at 500 H.P., but can easily be increased. The turbines proposed to be used

are the Poole and Hunt-Leffel type, and the dynamos of the Edison type.

THE Curtis Bay Electric Railroad Company is double tracking its line between Curtis Bay and Baltimore.

THE Pullman Company is building 300 gondola cars for the Columbus & Hocking Valley Coal & Iron Company.

THE construction of a boulevard between Baltimore and Washington, which has been discussed for a long time, is said to be approaching a practical stage. With the boulevard a traction system is said to be linked. About all the necessary legislation to enable the plans to be successfully completed has been passed, and men with ample capital to carry out the idea are said to have taken hold of the enterprise, which is now backed by the capitalists of the Baltimore Traction Company. In the session of the Maryland Legislature last winter, an act which was approved April 7 was passed, incorporating the Baltimore & Washington Turnpike & Tramway Company. The incorporators named included a number of well-known persons living along the route of the proposed road. A few days after the approval of the act the subscription books were opened at Laurel, under the provisions of the act, and all the stock was subscribed, a majority of the subscriptions being taken in the interest of the Baltimore Traction Company. Immediate action in the building of the road was prevented, it is said, on account of the inability to complete the road farther than the northeastern line of the District of Columbia, as the charter from the Maryland Legislature could only empower the building of the line to that point. A bill was pushed through Congress, and approved recently, which provides for the necessary link of the road within the District of Columbia. One of the directors states that the boulevard will undoubtedly be built. The absence of many of the directors from the city at present will probably cause a delay in the commencement of active operations until fall, he added, but by the latter part of September a meeting will probably be held and the work laid out. No details of the constructions have been arranged, and it is said the necessary surveys have not been made. It is said electricity will be the motive power on the tramway.

THE General Manager, J. T. Odell, of the Baltimore & Ohio Railroad, has just completed an inspection trip over the Grafton & Greenbrier Railroad. This road has recently been acquired by the Baltimore & Ohio, and its name has been changed to the Grafton & Bealington Railroad. It was formerly operated as a narrow-gauge line, but has been changed to standard gauge by the Baltimore & Ohio. The Grafton & Bealington is 42 miles long, and extends eastwardly from Grafton. The West Virginia Central Railroad Company has built a connecting link, 16 miles long, from Elkins, on its main line, to Bealington, where a connection is made with the new link of the Baltimore & Ohio. An agreement has been entered into between the Baltimore & Ohio and the West Virginia Central for an interchange of freight traffic in a few days. By the completion of these links the West Virginia Central will have direct communication with the leading trunk lines East and West, and the Baltimore & Ohio will secure a share of the valuable coal, coke and lumber traffic of West Virginia, which has its outlet over the West Virginia Central. The extension and enlargement of the two roads will give the iron fields of Northern Virginia, the coal, timber, and ore fields of West Virginia, and the Pennsylvania forests adjacent a short connection to the trunk lines, so that they can be more easily reached from all points East and West. Much of this traffic has heretofore taken a circuitous route to reach its destination.

THE Baltimore & Ohio Southwestern has ordered 20 side-dump cars from the Pullman Company.

THE Carlisle Manufacturing Company is just completing an order of 300 cars for the Monongahela River Railroad, and is also about to build 100 each for the Fairmount Coal & Coke Company and the Gaston Coal Company.

THE South Baltimore Car Works will build 100 cars for the West Virginia & Pittsburgh Railroad for the logging trade. They will be flat cars, especially strong, and with 30-in. wheels.

Car Lighting.

THE Midland Railway of England has adopted the Pintsch light as the standard method of illuminating its passenger cars. The company has already caused the erection of three gas plants at various points along the line, and has ordered equipment for 886 cars. This company has abandoned the use of the electric system of lighting which it has had in use for several years, as it was found to be expensive and unreliable for service; and after due consideration it has taken up the Pintsch system as being the cleanest, safest and most economical method of car lighting.

The Servé Ribbed Boiler Tube.

SOME reference has heretofore been made to the Servé ribbed boiler tube, and the advantages which it offers of increasing the heating surface of boilers, with a corresponding economy of fuel.

Recent orders for marine boilers include sets of tubes for a steamer of the Allan transatlantic line, and one for the Cunard line. These tubes are now in use on the new steamer *Mascotte* of the Plant line, running between Port Tampa and Havana.

For locomotives the first company to adopt these tubes was

SECTION OF A SERVÉ RIBBED BOILER TUBE.

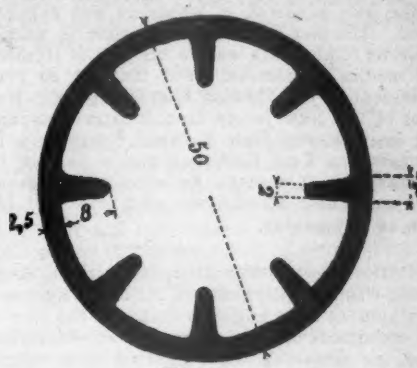


Fig. 1.

the Paris, Lyons & Mediterranean in France; on that road 100 locomotive boilers are fitted with them, and have done so well that 100 more sets were recently ordered. They are also in use on the Great Eastern in England.

In this country ribbed tubes are in use on the Grand Trunk in Canada, and experimental sets have lately been ordered by the Canadian Pacific, the Mexican Central, the Southern Pacific and the Pennsylvania Railroad.

PERSONALS.

H. H. GLADDING has been appointed Assistant City Engineer of New Haven, Conn., succeeding J. S. MORLEY resigned.

THOMAS HASSARD, for 10 years past Engineer in the office of the United States Commissioner of Railroads, has resigned on account of continued ill health.

C. G. WALDO has been appointed Assistant to the President of the Cincinnati, Hamilton & Dayton Railroad Company, and GEORGE R. BALCH has been made Purchasing Agent of the same company.

J. O. PATTEE, for some time past Master Mechanic of the Great Northern Railroad, has been appointed Superintendent of Motive Power of the Great Northern and all its controlled and proprietary lines.

RICHARD RELF, of St. Paul, Minn., has been appointed Engineer in the office of the United States Commissioner of Railroads. Mr. Relf has been for many years connected with the Northern Pacific Railroad.

CHARLES C. MORRISON, formerly President of the Columbia Bridge Company, of Dayton, O., has opened an office in Milwaukee as Consulting Bridge Engineer. He will also represent the Lafayette Bridge Company.

COLONEL CARY A. WILSON has been appointed Chief Engineer of Maintenance of Way on the Missouri, Kansas & Texas Railroad. He was formerly Chief Engineer of the East Tennessee, Virginia & Georgia Railroad.

LOUIS COSTE has been appointed Chief Engineer of Public Works of the Dominion Government. He has filled the position for about a year under a temporary appointment, and, although still a young man, has had charge of many important works.

OBITUARIES.

COLONEL HENRY CLAY NUTT, who died in Chicago, August 15, aged 59 years, was born in Montpelier, Vt. As a boy he found employment on the Vermont & Canada Railroad, and later was successively a rodman, assistant engineer and conductor on the Plattsburg & Montreal Railroad. From 1851 to 1855 he was Chief Engineer of construction and location of the Peoria & Oquawka Railroad (now part of the Chicago, Burling-

ton & Quincy), and from 1857 to 1860 was Chief Engineer of the Council Bluffs & St. Joseph road; afterward he was a general steamship, express and railroad agent in Chicago. In 1881 he went to Boston to accept the presidency of the Atlantic & Pacific Railroad. In consequence of ill health Colonel Nutt found it necessary in 1889 to resign, and returned to Chicago to live.

Benjamin G. Clarke, who died in Antwerp, August 12, aged 72 years, had been for many years a leading man in the iron trade. He was born in Easton, Pa., and was brought up to the iron business, in which he was engaged from his boyhood. He had been for some time in failing health, and at the time of his death was on his way to Hombourg in Germany for medical treatment. For the last 20 years he had been President of the Thomas Iron Company. He was also President of the New Jersey Zinc & Iron Company; Chairman of the Lackawanna Iron & Steel Company; President of the Lackawanna Coal Company and a director in the Delaware, Lackawanna & Western Railroad. He was a member of several clubs and associations, and was well known socially as well as in business.

Hugh Riddle, who died in Chicago, August 10, aged 70 years, was born at Bedford, N. Y., and at an early age found employment in an engineer corps on the Erie Railroad. With the exception of two years on the old Buffalo & State Line road, he remained with the Erie until 1869, rising through various grades to the position of General Superintendent. In 1869 he went to Chicago as General Superintendent of the Chicago, Rock Island & Pacific Railroad. In 1871 he became Vice-President of that company and in 1877 he was elected President, serving in that capacity until 1883. He was associated with Charles Francis Adams on the Trunk Line Committee in 1884, and in 1885 he was elected a director of the Union Pacific. Some years ago he retired from active work, and has since lived quietly in Chicago.

General William Petit Trowbridge, for 16 years Professor of Engineering in the School of Mines in Columbia College, New York, died suddenly in New Haven, Conn., August 12, aged 64 years. He was born in Oakland County, Mich.; at 16 he secured the appointment to the Military Academy, West Point, from his district, and was graduated at the head of his class in 1848. He was assigned to the Engineer Corps and was made a first lieutenant in 1854. In his last year at the Academy, although he was but 19 years old, he acted as assistant professor of chemistry, and for two years after that took a special course in the astronomical observatory there, fitting himself for service in the Coast Survey, to which he had asked to be assigned. In 1852 he took charge of the triangulation of the coast of Maine, and the following year he was sent to the Pacific Coast, where he remained until 1856 making tidal and magnetic observations. He resigned in December of that year to take the chair of mathematics in the University of Michigan, but a year later went back as permanent assistant in the Coast Survey. When the war broke out General Trowbridge was placed in charge of the engineer office in New York City, where he looked after the supply of materials for fortifications and the construction and shipping of supplies to engineers in the field. He superintended the engineering at the building of the fort at Willett's Point and the repairs on Fort Schuyler and Governor's Island. In 1865 he became Vice-President of the Novelty Iron Works, and remained there for four years, when he was elected Professor of Dynamical Engineering at Yale. In 1876 he went to Columbia to succeed General Vinton in the engineering chair.

He was Adjutant-General of the State of Connecticut on Governor Ingersoll's staff from 1873 to 1876, and held a number of State offices. Degrees were conferred on him by Rochester, Yale, Princeton, Trinity and the University of Michigan. General Trowbridge was a member of the National Academy of Sciences and presided over the American Association meeting in 1882. He published a number of books on engineering, but was most famous as the man who first suggested the idea of the cantilever bridge.

PROCEEDINGS OF SOCIETIES.

Master Car and Locomotive Painters' Association.—The Secretary, Mr. Robert McKeon, has issued notice of the Annual Convention, which will be held in Detroit, Mich., beginning at 10 A.M., September 14. The headquarters will be at the Russell House, where special arrangements have been made for delegates, with the uniform rate of $3 per day. An invitation is extended to all foremen car and locomotive painters to attend and to become members of the Association.

At the last Convention Committees were appointed to report upon the following questions:

1. Would it be practicable for railroad companies to adopt the piece-price system in the Paint Department; if so, what plan and schedule can be suggested for doing the work so as to cover all classes of paint-shop work upon locomotives and cars?
2. What is the best method of making putty for passenger-car work? Is it advisable to use any coloring with lead in mixing hard-drying putty?
3. In what manner should the outside surface of a passenger car be treated that has a good foundation but requires recovering? Should the varnish be removed before recovering?
4. What can be done by members of this Association to make it of greater benefit to Master Painters and the companies which they represent?
5. The advantages, if any, which might accrue to the members of this Association from the appointment of a standing Arbitration Committee.
6. Requisitions for material in the railroad paint shop. How should they be made?
7. Which are the most durable light or dark colors on passenger car bodies? Which is the least expense to maintain, yellow, Pullman color or Tuscan red?
8. By our experience as Master Painters, are we satisfied that passenger cars are receiving proper care at terminals? What plan and material can we recommend to improve upon the general appearance of the equipment while in service, and also increase its durability?
9. What is the difference in cost of painting a passenger coach with yellow, Pullman color or Tuscan red?

In addition to these reports to be submitted by committees, the following queries will be presented to the Convention for general discussion:

1. Do you paint your engine frames with color and then varnish them, or do you use asphaltum?
2. How do you clean the paint and varnish from glass?
3. In touching up and revarnishing a coach is it economy to thoroughly clean and touch up the deck and trucks, or to paint them over?
4. How do you use gold and copper bronze for seat arms, heater pipes, etc., dry or mixed?
5. Which is the best gilding size, slow or quick?
6. In cutting in a coach with color, do you use it mixed in the same way as when giving a general painting?
7. Do you give the sashes the last coat of varnish before or after they are put in?
8. Has any member ever found a paint remover that he felt sure would not injure the wood or subsequent painting?

Master Mechanics' Association.—A circular from Secretary Angus Sinclair announces the subjects for discussion and the Committees for the current year as follows:

Exhaust Pipes, Nozzles and Steam Passages.—C. F. Thomas, A. W. Gibbs, S. Higgins, J. M. Wallis, George W. Smith, Robert Quayle, John Y. Smith.

Standard Tests for Locomotives.—To investigate the practicability of establishing a standard system of tests to demonstrate the fuel and water consumption of locomotive. Also to ascertain the value of the steam-engine indicator in locomotive tests. J. N. Lauder, W. J. Robertson, Albert Griggs, John D. Campbell, F. W. Dean.

Compound Locomotives.—To investigate the relative economy of compound and simple locomotives; also the most valuable form of compound locomotives. George Gibbs, William H. Lewis, Pulaski Leeds, James Meehan, T. W. Gentry, A. T. Woods. Auxiliary Committee.—S M. Vauclain, Baldwin Locomotive Works; Reuben Wells, Rogers Locomotive Works; H. N. Sprague, Porter Locomotive Works; A. J. Pitkin, Schenectady Locomotive Works; Joseph Lythgoe, Rhode Island Locomotive Works; F. J. Leigh, Canadian Locomotive Works; D. A. Wightman, Pittsburgh Locomotive Works; H. Tandy, Brooks Locomotive Works.

Tests of Iron and Steel.—To test the critical temperature of iron and steel; also any other questions relating to steel and iron that the Committee may consider of value. William Smith, J. N. Barr, A. W. Quackenbush, P. H. Peck, D. L. Barnes.

Uniform Locomotive Performance Sheets.—To report on the practicability of establishing a system of recording the performance of locomotives that will fairly represent the work done. George F. Wilson, J. S. McCrum, John Player, James McNaughton, John A. Hill.

Standard Diameters for Wheel-Centers and Tires.—

To report on Dimensions of wheel-centers for driving-wheels larger than the standard; also to investigate the means of securing uniformity in rolled outline of standard tires. A. E. Mitchell, W. C. Ennis, Thomas Millen, C. A. Thompson, L. R. Pomeroy.

BOILER ATTACHMENTS.—How can the safety of these be increased and how can the number of holes in a boiler be lessened? James Macbeth, A. Dolbeer, J. M. Boon, W. A. Foster, M. N. Forney.

MALLEABLE IRON CASTINGS.—To what extent can these be used to take the place of expensive forgings? R. H. Soule, W. Garstang, W. H. Thomas, C. H. Cory, W. D. Crossman.

ATTACHMENTS BETWEEN ENGINE AND TENDER.—Suggest improved form that will prevent the tendency for the tender to mount the foot-plate; also to report on foot-steps and hand-rails. J. Davis Barnett, G. W. Stevens, C. E. Smart, W. S. Morris, L. S. Randolph, L. F. Lyne.

SMOKE PREVENTION.—Recommend methods of smoke prevention that will satisfy municipal requirements in cities. J. N. Barr, F. Mertsheimer, P. W. Gentry, William McIntosh, W. H. Marshall.

TENDER FRAMES.—Reports on best form of tender and truck frames of wood and iron. R. C. Blackall, E. E. Davis, John Mackenzie, T. Purves, Jr., F. B. Miles.

OBITUARY NOTICES.—Subject and Committee: Ross Kells—Leroy Kells; William F. Turreff—William Fuller; Joseph Brandt—A. Dolbeer; S. D. Bradley—J. E. Keegan; Edward Nichols—M. L. Hinman; William Smith—E. E. Davis; William Wilson—A. Quackenbush; O. A. Haynes—H. Elliot; James Sedgley—G. A. Stevens.

APPLICATIONS FOR ASSOCIATE MEMBERSHIP.—George H. Baker—Committee, J. N. Lauder, William Swanston, R. H. Briggs. John H. Leeds—O. Stewart, J. D. Campbell, F. W. Twombly. H. P. Robinson—J. N. Barr, G. F. Wilson, Peter H. Peck.

SUBJECTS FOR INVESTIGATION.—George Gibbs, William Smith, E. M. Roberts.

DELEGATES TO CONVENTION OF AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS.—J. N. Lauder, John Mackenzie.

EXECUTIVE COMMITTEE.—John Hickey, R. C. Blackall, William Garstang, O. Stewart, Angus Sinclair.

Southern & Southwestern Railroad Club.—A meeting was held at the Kimball House, Atlanta, Ga., August 18. Committee reports were made on Repair Work on Large Systems and the Best Location of Plants and on the Best Form of Performance Sheet. There were three subjects for discussion, the first being Joint Inspection, the second—a closely allied one—Charges for Material in Freight-Car Repairs, and the third, the Effect of Wear on Locomotive Cylinders from Piston Packing.

Virginia Association of Engineers.—The regular meeting was held in Richmond, Va., July 4 and 5. The meeting was opened by the annual address of President Clarence Coleman. The following new members were elected: Frank Backman, William G. Brown, Julian R. Downman, J. H. Dunstan, Samuel G. Gaillard, James S. Green, James C. Meen, John T. Morgan, Walter L. Patterson, Archibald L. Sproul, William B. Stephens. In addition Colonel E. T. D. Myers was elected an honorary member.

The reports of the Secretary and Treasurer, covering six months' work, were received.

The Committee on Highway Improvement presented a report of progress, and was continued. The report on this subject will be a leading topic for discussion at the next meeting.

The following papers were read at the meeting: Necessity of Co-operation among Engineers, T. W. M. Draper; A National Railroad College, Herman Coneger; Easement Curves, Charles H. Rice; Need of a Weather and Signal Station at Roanoke, Charles H. Churchill; The Iron Pier at Lambert's Point, W. W. Coe; Work of the First Mining Engineer in the Colony of Virginia, W. H. Adams.

Technical Society of the Pacific Coast.—At the regular meeting, August 5, Mr. John Pitchford read a paper on the Corliss Engine. This was followed by one on Hydraulic Passenger Elevators, by Horace B. Gale, and Lieutenant John D. Finley made some remarks on the general circulation of the atmosphere.

Engineers' Club of Cincinnati.—There was a very good attendance at the June meeting of the Club.

The subject, "What to do with Mill Creek and its Valleys," was taken up and discussed by Colonel W. L. Robinson in a short paper on the subject, advocating the filling of the valley for a certain distance, and appropriating the same for railroad yards and terminals, reserving space for the passage of the creek. Its use for a harbor of refuge for steamboats and as a terminal for a ship canal, to be made by enlarging the Miami Canal, was also advocated by some. The valley is being slowly filled as new streets are made and improvements established within its limits, but no definite action looking to its ultimate availability has ever been taken. The valley within the city limits proper is a mile or more in length and half a mile or more in width, and from 20 to 40 ft. below the established grade of the streets in that vicinity, and the question as to the ultimate use to which it would be put has been and is a problem requiring for any purpose the expenditure of millions of dollars and years of time.

NOTES AND NEWS.

Bridging the Bosphorus.—A commission has been appointed by the Turkish Government to consider a project for building a bridge across the Bosphorus from Stamboul to Scutari. The proposed bridge is to carry a railroad track, a tramway, a carriage road, and foot walks. In connection with this it is proposed to extend the Anatolian Railroad from its present terminus at Haidar-Pasha to Scutari, and across the bridge to a connection with the line from Constantinople to Budapest.

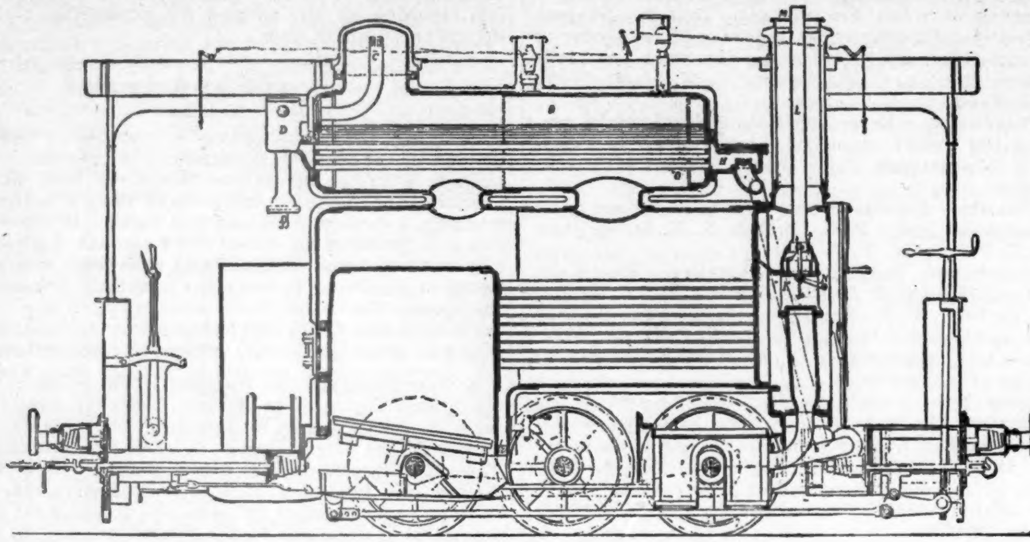
The proposed bridge will be about 6,600 ft. long, but nothing is said as to the spans or the method of construction.

A Four-thousand-ton Forging Press.—The Bochum Mining & Steel Company, at Bochum, Germany, has taken to the use of hydraulic presses for forging steel ingots on a considerable scale, the largest being of 4,000-ton squeezing power. This is constructed on Fritz Baars' patent, with a central ram divided into two parts of unequal diameters, the lower half being 930 and the upper 530 mm., and arranged for three different working pressures in the proportion of 1 to 2 to 3, the effect in these cases being 1,300, 2,700, or 4,000 tons, at a maximum pressure of 600 atmospheres. The lift of the ram is 1.5 meters, and is invariable, the cross-head carrying the cylinder being fixed and not adjustable in height, like the presses made by Messrs. Tannatt, Walker & Company. The return-stroke of the ram is made by two 260 mm. plungers, which are subjected to a pressure of 50 atmospheres, and also serve as guides for the down-stroke. All the parts are cast in steel; the top cross-head, which is in two pieces, weighs 64 tons, and the cylinder of 35 tons weighed 57 tons in the rough casting. The press is manipulated by a slide-valve, moved by a lever which has only 600 mm. travel, and requires an effort of only 3 kg., being only subjected to the lower pressure of 50 atmospheres, the same pressure being used for moving the high-pressure admission and exhaust-valves by means of pistons. The path of the hand-slide is divided into three parts; the first opens the exhaust, the second the 50-atmosphere admission, and the third that for 600 atmospheres, the latter being only admitted when the ram is actually in contact with the ingot or block, and work is required to be done upon it. This makes the press very economical in work, the 4,000-ton pressure being obtained by a twin steam-pump, with cylinders 760 mm. diameter and 920 mm. stroke, cutting off at one-fifth, and making 30 revolutions per minute. The accumulator, with a compressed-air resistance, has a plunger 225 mm. diameter, and a length of stroke of 3 meters. The lower-pressure water is provided by a pair of engines 460 mm. diameter and 700 mm. stroke, pumping into a dead-weight accumulator of 450 mm. diameter and 3.5 meters lift. The engines for both high and low-pressure water, and the accumulator for the former, are provided in duplicate. The press stands in the center of a forge 33 meters in diameter, the top forming the pivot for a radial crane of 275 tons lifting-power, whose outer pillar travels on a circular railroad, the heating furnaces being arranged round about two-thirds of the circumference, in the same manner as in the large hammer forges at Bochum and Terni; there are also two pieces of apparatus for turning the work, which can be used in addition for drawing and charging the heats. These, together with the crane, are driven by the 50-atmosphere accumulator.—*Iron.*

Resistance of the Air to Falling Bodies.—Some interesting experiments on falling bodies and the resistance of the air have been recently made by MM. L. Cailletet and E. Colardeau at the Eiffel Tower, and the results have been communicated to the Paris Academy of Science. Spheres of metal were allowed to fall from the second platform of the tower, and the exact time of falling certain distances was measured to the hundredth of a second by an electric chronograph. Care was taken to eliminate any source of error, and the authors find (1) that the resistance of the air is proportional to the area of the resisting

surface, but independent of its form ; (2) that it is proportional to the square of the velocity is not strictly true, as the resistance increased rather more rapidly ; (3) the amount of fall after which the velocity of the weights employed became uniform ranged from 60 to 100 meters.

A French Tramway Locomotive.—The accompanying cut shows a section of a locomotive intended for tramways or suburban work, devised by MM. Leon Franq and Mesnard. The general idea is of a locomotive with an ordinary fire-box, but provided with a boiler in which a supply of steam can be stored for use in tunnels or at points where it is desirable to suppress the exhaust and blast. The boiler, it will be seen, carries above it a cylindrical reservoir, which carries the detaining valve and reheater. This reservoir nearly doubles the quantity of hot water contained in the boiler and provides a reserve which can be drawn upon when needed.



LOCOMOTIVE FOR TRAMWAY OR LOCAL SERVICE.

The reducing valve *D* receives steam from the dome through the pipe *C*, reducing it to a pressure regulated by the action of the balance *E* on the lever *F*. The steam is passed into the tubular reheater *G*, where it is dried before passing to the throttle valve *H*.

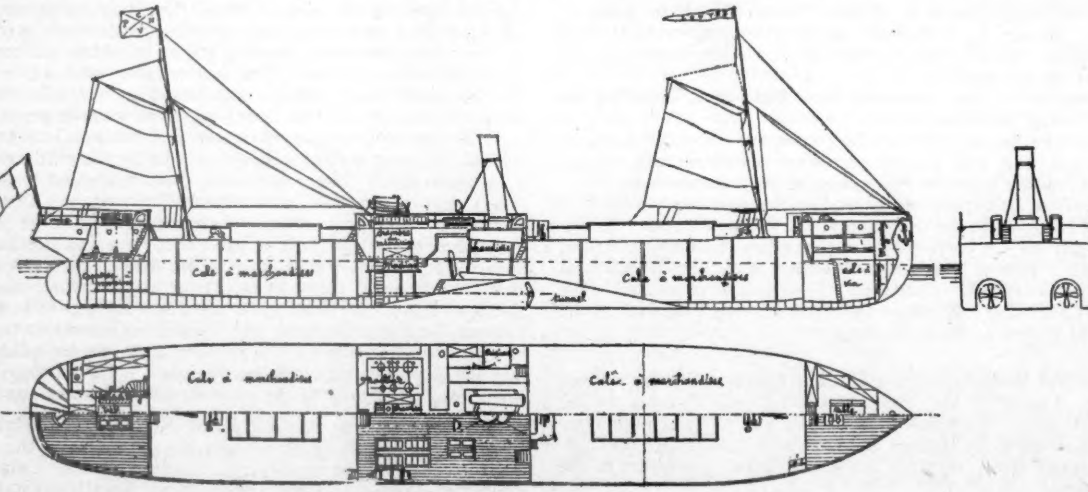
When the blast is to be stopped the hood *M* is drawn over the top of the stack, and the exhaust turned through *K* into the pipe *L*, whence it escapes into the air. When the blast is to be put on again, and active combustion in the fire-box resumed, the pipe *L* is lowered and the hood *M* drawn back.

It has been proposed to apply also a system for condensing the exhaust steam, but this has not yet been carried out. The locomotive shown is a small six-wheel connected engine for suburban traffic. Several of these engines have been built for the Northern Railroad of France for use on the lines entering Paris.

Rails in Tunnels.—Some observations recently made in the Altenberg Tunnel, in Germany, which is 1,230 ft. long, on rails which had been laid 11 years, showed that they were covered to a depth of 0.16 to 0.24 in. by hard scales, which could only be removed by a knife. They were composed mainly of iron sulphide, and were found principally on the web. While the weight of the rail was much reduced in this manner, its sectional area was found to have increased, owing to the flaky character of the rust. The new rails have been covered with a mixture consisting largely of tar, which is renewed every six months. The gravel ballast has also received a partial covering of broken limestone, and by these means it is hoped that the formation of rust will be retarded. In the Brandleite Tunnel, in Thuringen, it was found that rails and metal ties were destroyed by rust as fast as by the passing trains. The ties lost about 5.9 lbs. each in six years. This tunnel is nearly 10,000 ft. long.

A Center-Screw Boat.—The accompanying sketches, from *Le Yacht*, show a longitudinal section, a cross section and a plan of the *Louvre*, a vessel of novel construction, built to run between Paris and Bayonne, and so necessarily adapted to both river and coasting work. The shallow waters of the Seine limited the draft to 9.1 ft., and the vessel is accordingly made flat bottomed ; she is 171 ft. long, 27.9 ft. beam, and has a displacement of 800 tons when fully loaded.

The chief peculiarity is the adoption of M. Oriolle's plan of placing the screws at the center of the boat, in tunnels made to receive them. Their position is shown in the sketches. There are two of these screws, each 5.9 ft. in diameter and 6.5 ft. pitch. Hatchways are provided, so that any repairs to shafts or screws can be made without docking the vessel, the hatches being enclosed to a point above the water-line.



FRENCH CENTRAL-SCREW BOAT "LA SEINE."

On the voyage from Nantes, where she was built, to Paris, the *Louvre* encountered some very rough weather off Ouessant, and proved herself a good sea boat. With the engines running 60 revolutions a minute, she reached a speed of 10 knots an hour.

A Passenger Whale-back Steamer.—The accompanying diagrams show the design which accompanies the application for an English patent for a passenger steamer of the so-called

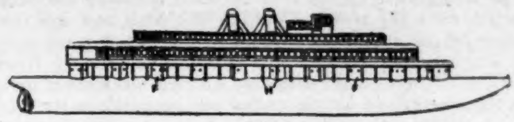


FIG 1

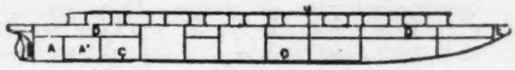


FIG. 2

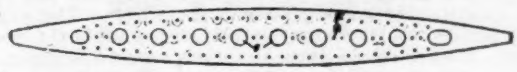


FIG 3

FIG. 4

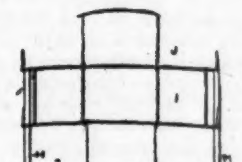


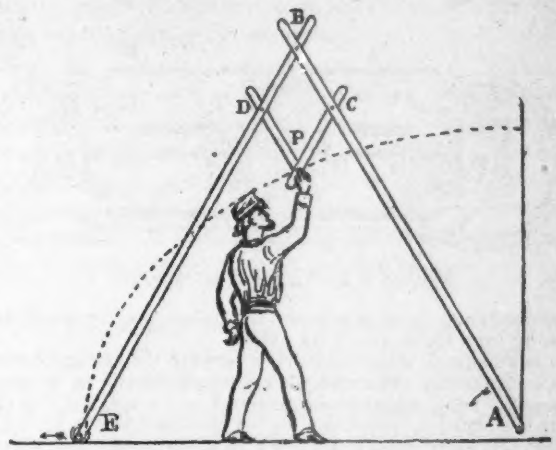
FIG. 5.

A WHALE-BACK PASSENGER STEAMER.

whale-back type. The general features of the proposed ship are shown in the drawings, figs. 1, 2, 3, 4 and 5, which represent a side elevation, a longitudinal vertical section, a plan of the hull, a front elevation, and a transverse section respectively. The hull has longitudinal and transverse bulkheads, and a water bottom having a metallic top, *C*, which forms a false bottom for the vessel. The bulkheads extend from the false bottom to the top of the hull, thus preventing the admission of water in case of the vessel being thrown out of its equilibrium. *D* represents a deck situate some distance below the top of the hull, which may be of any length. $A\ A^1$ are the engine and boiler rooms. The engines may be of any suitable number, but preferably three, for operating triple screws. A collision chamber, *E*, is provided at the bow, and a deck, *G*, is secured to metallic turrets *F* and additionally supported by stout braces *H* shown. These braces, which are virtually pipes, also serve for ventilation purposes. The hull is accessible from the cabin *I* by staircases through the turrets. A modification of this type of vessel is described, in which the cabin extends from a point near the stern to a point midway between the bow and stern.

How to Draw an Ellipse.—Mr. Richard Inwards writes to the *English Mechanic* as follows: "There are already so many ways known of drawing elliptic curves, that I feel some doubt as to whether I ought to trouble your readers with a new one which has occurred to me; but as the curve can be made with so simple an apparatus as four wooden rods and five wire nails, I think it may perhaps be useful to masons and scene painters who want to set out elliptic arches, or to draw circles in perspective. By this plan it is not necessary to find the foci of the ellipse, nor is any cord required.

"Let *A B* be a rod in length equal to half the longest diameter of the ellipse, and *B E* be another rod exactly similar, except that it may with advantage be fitted with a roller on its lower end. The distance *C B* is to be equal to half the difference between the long and short semi-diameters of the ellipse.



DRAWING AN ELLIPSE.

C B, *C P*, *P D*, and *B D* are all equal; in other words, they form a rhombus *B C P D*. *A* rotates on a nail fixed in the center of the ellipse, while *E* slides along *A E* (the floor will do very well); then the point *P* must describe a quarter-ellipse, whose respective dimensions are settled by the first adjustment of the lengths *A B* and *C B*. The other quarters can be got by reversing the instrument. The curve is a true elliptic one, and it may amuse some of your readers to work out the proof."

An Aluminum Boat.—Some reference has been before made to an aluminum boat built by the firm of Escher, Wyss & Company, of Zurich, Switzerland. The accompanying drawing, from *Le Yacht*, shows a second boat of this kind lately completed by that firm and now in use on the Lake of Geneva. This boat—the *Zephyr*—is 17.2 ft. long, 4.9 ft. beam, 2.2 ft. in depth and draws 1.6 ft. of water. She is driven by a petroleum engine.

In the drawing fig. 1 is a longitudinal section; fig. 2 a half plan and fig. 3 a half cross-section. In fig. 1 *A* is the anchor well; *B* the reservoir of oil; *C* the boiler or vaporizing chamber; *M* the engine; *V* the starting valve; *P* the pump; *R* the steering wheel.

The boat is entirely of aluminum except the seats, the side-rail *D D* and the floor gratings *E E*, which are of mahogany. The anchor and chain are of iron. The hull is of aluminum plates stiffened by ribs of the same metal, and the rivets joining the plates are of aluminum. The motor is rated at 2 H.P., and gives a speed of 6½ miles an hour, which is very fair, considering the size of the boat and the fact that she is not especially designed for speed. The total weight of the boat, all ready for use, is 948 lbs., of which the aluminum in her construction forms only 287 lbs.

Fig 1

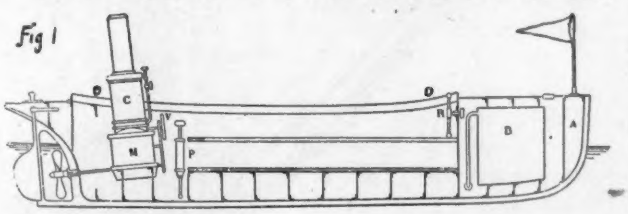


Fig. 2.

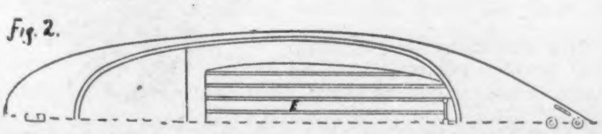
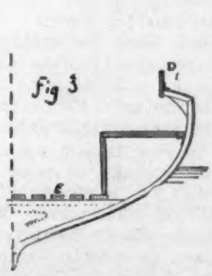


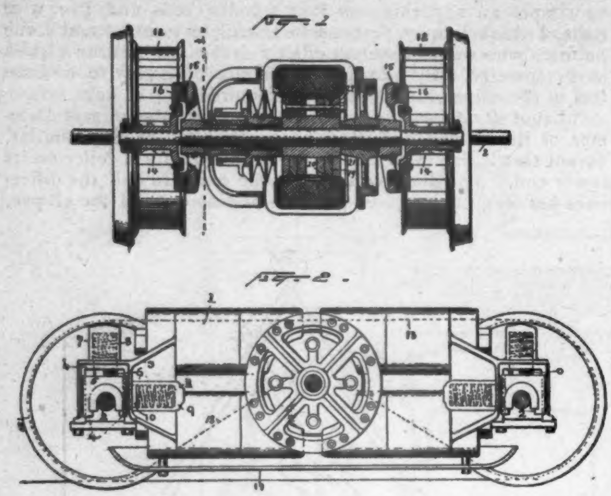
Fig 3



AN ALUMINUM BOAT.

The Escher-Wyss works are now building a third boat—the *Mignon*—which will be 40 ft. long and will be designed for speed. She will have a cabin and two masts, and will be also entirely of aluminum except the seats, floor and cabin fittings.

The Edison Electric Locomotive.—Mr. Thomas A. Edison has lately patented a new form of electric locomotive, the main object of his device being to support the motor directly from the car-axles in such manner that the axles may be capable of moving slightly relative to the motor, as hereinafter



EDISON'S ELECTRIC LOCOMOTIVE.

described, and in such manner that power may be transferred readily from the motor to the axles.

1 is an electric motor supported between the two axles 2 2 of the car or truck. The motor is supported directly on the axles, instead of being mounted on the frame of a truck, and this support is effected by providing one or more brackets 3, having at their outer ends boxes or sockets 4, in which are movable spring-pressed blocks 5 resting on the axles. The blocks can move vertically or horizontally in their boxes. From the upper side of each block projects an extension, 6, into a holder, 7, forming a part of or secured to the box 4. Within said holder is a spring, 8, of sufficient strength to support its proportion of the weight of the motor, but capable of slight compression when the truck is subjected to sudden jars. There are preferably two of these blocks 5 at each end of the motor.

9 is a second socket or holder on the face of the box toward the motor. Within this holder is a freely movable block, 10, which is pressed against the block 5 by the spring 11. Said arrangement of the block 10 will permit the necessary vertical movement of block 5. The springs 11 should be of sufficient strength to withstand the pull of the motor communicated through a belt or otherwise to the car-axle, but should be capable of yielding slightly under any unusual or severe strain.

12 are pulleys on the car-axles.

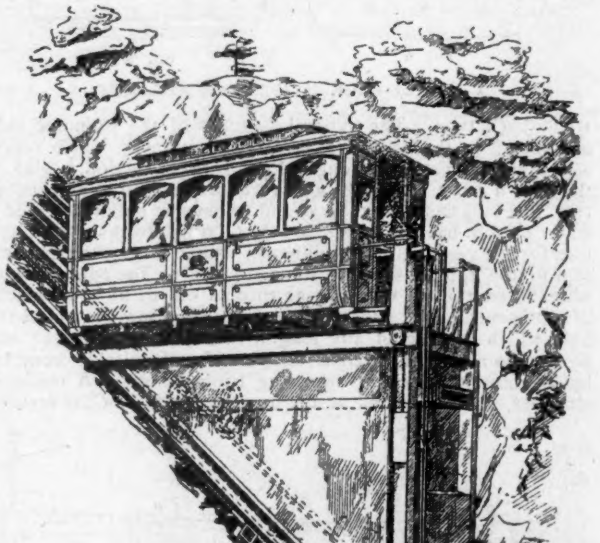
13 is a belt, preferably a chain belt. Said chain passes around a pulley on the front axle and a pulley on the rear axle, and is engaged by the cog-wheel or drum 14 on the motor-shaft. Two such chains are used, one on each side of the car. Motion is transmitted from the motor to the cog-wheel by means of a magnetic clutch consisting of one member 15 fixed to the motor-shaft, and a second member, 16, fixed to the cog-wheel and capable of turning therewith.

17 is a pan or plate under the motor to protect it from dirt. On the car-axles outside of the wheels are or may be placed the usual boxes or devices for supporting the car-body, the boxes for supporting the motor being between the wheels.

With the arrangement described when the motor is set in motion and the magnetic clutch is energized motion is conveyed to the chain belt and thence to the pulleys on the car-axles. The pull of the belts tends to draw the axles toward the motor, but owing to the strength of the springs said axles are not moved appreciably; but when for any reason an unusually severe strain or pull is given the springs, or some of them yield, allowing the block or blocks 5 to move in their boxes, thus avoiding injury to the chain or other parts. When the motor is mounted as described, it also allows the axles to move slightly independently of each other, as is desirable and necessary when the vehicle is rounding a curve. The motor ring-armature is slightly thicker at the center 18 than at the edges, so that the inner face has an inclination from the central line toward both edges, and the blocks or rings 19, which are placed around the hub on the motor-shaft, have their outer sides or peripheries 20, as well as their inner sides 21, beveled, so that said blocks or rings when drawn together by bolts 22 are securely wedged between the hub and armature-ring and firmly hold the latter in place.

A Novel Inclined Railroad.—The Bridgnorth Castle Hill Inclined Railway was opened on July 7 by the Mayor and Corporation of Bridgnorth. The ceremony of starting the first car was made the occasion of a holiday in the ancient borough, whose history as a town goes back to the time of the Danes. The picturesque scenery of this spot, the far-famed Castle Hill Walk, has not been interfered with, as Mr. G. Croydon Marks, the Engineer of the work, has concealed his railway in a cutting made some 50 ft. into the rock.

The Bridgnorth Castle Hill Inclined Railway has been constructed with the view of uniting the high and low towns of Bridgnorth, at present separated by a flight of some 200 steps and long sloping paths. The proposal emanated from Mr. Marks, of Birmingham, who had carried out similar undertakings elsewhere, and acting under his suggestions the Corporation of Bridgnorth assisted in the formation of a company for the purpose of constructing the railway. In November of last year the first piece of rock was cut, and ever since then the task of cutting through some 50 ft. of solid red sandstone has been going on. The gradient or inclination of the track is a rise of 1 ft. in a horizontal length of about 1½ ft., and the cutting has a vertical depth at one place of about 50 ft. The length of the track is 201 ft., and the vertical rise or lift is 111 ft. The system of working the inclined cars is covered by patent, embodying also the engineer's experience gathered from the working of other undertakings similar to the one on the northeast coast. The motive power is water, employed as a balance or counterweight, which is led into one car when at the top of the track, to overbalance and draw up the companion car at the bottom of the track. The two cars, each capable of carrying 18 passengers, run on independent pairs of rails, and are securely connected to each other by two steel wire cables, each of which is amply strong to do the whole work. Thus as one water-weighted car descends it causes the companion car to ascend. The steel rails are secured to sleepers bolted down to the rock, each sleeper being also held in position by being embedded into concrete blocks. Water is pumped from the bottom to the top tank by means of a pair of double-acting horizontal pumps, driven independently by a pair of the latest type "Forward" gas engines. The rope for connecting one car with the other is duplicated, both being steel wire cables of Craddock's make, each capable of sustaining a load 15 times



THE BRIDGNORTH INCLINED ROAD.

that which has to be brought on to the cars. Automatic wedge brakes come into action in the event of either, or, what is impossible, both of the ropes breaking. Brakes also come into play if too great a speed is attained, and instantly arrest the motion of each car by gripping the rails on all four sides. Cars cannot run down the incline by themselves, and if left untouched they will stop. It is only when both brakemen wish the cars to go that they can move.—*The London Engineer.*